CE

User Manual

PSI 9000 3U Series

DC High Efficiency Power Supply

Attention! This document is only valid for devices with TFT display and firmware “KE: 2.10”, “HMI: 2.02” and “DR: 1.6.3” or higher. For availability of updates for your device check our website or contact us.

INTEPRO
SYSTEMS

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1. General

1.1 About this document

1.1.1 Retention and use

This document is to be kept in the vicinity of the equipment for future reference and explanation of the operation of the device. This document is to be delivered and kept with the equipment in case of change of location and/or user.

1.1.2 Copyright

Reprinting, copying, also partially, usage for other purposes as foreseen of this manual are forbidden and breach may lead to legal process.

1.1.3 Validity

This manual is valid for the following equipment including derived variants.

Model	Article nr..	Model	Article nr..	Model	Article nr..
PSI 9040-170 3U	06230350	PSI 9080-340 3U	06230357	PSI 9080-510 3U	06230364
PSI 9080-170 3U	06230351	PSI 9200-140 3U	06230358	PSI 9200-210 3U	06230365
PSI 9200-70 3U	06230352	PSI 9360-80 3U	06230359	PSI 9360-120 3U	06230366
PSI 9360-40 3U	06230353	PSI 9500-60 3U	06230360	PSI 9500-90 3U	06230367
PSI 9500-30 3U	06230354	PSI 9750-40 3U	06230361	PSI 9750-60 3U	06230368
PSI 9750-20 3U	06230355	PSI 91000-30 3U	06230362	PSI 91500-30 3U	06230369
PSI 9040-340 3U	06230356	PSI 9040-510 3U	06230363		

Changes and modifications for special models will be listed in a separate document.

1.1.4 Symbols and warnings

Warning and safety notices as well as general notices in this document are shown in a box with a symbol as follows:

	Symbol for a life threatening danger
	Symbol for general safety notices (instructions and damage protection bans) or important information for operation
	Symbol for general notices

1.2 Warranty

Intepro guarantees the functional competence of the applied technology and the stated performance parameters. The warranty period begins with the delivery of free from defects equipment.

Terms of guarantee are included in the general terms and conditions (TOS) of Intepro.

1.3 Limitation of liability

All statements and instructions in this manual are based on current norms and regulations, up-to-date technology and our long term knowledge and experience. The manufacturer accepts no liability for losses due to:

- Usage for purposes other than designed
- Use by untrained personnel
- Rebuilding by the customer
- Technical changes
- Use of not authorized spare parts

The actual delivered device(s) may differ from the explanations and diagrams given here due to latest technical changes or due to customized models with the inclusion of additionally ordered options.

1.4 Disposal of equipment

A piece of equipment which is intended for disposal must, according to European laws and regulations (ElektroG, WEEE) be returned to the manufacturer for scrapping, unless the person operating the piece of equipment or another, delegated person is conducting the disposal. Our equipment falls under these regulations and is accordingly marked with the following symbol:

1.5 Product key

Decoding of the product description on the label, using an example:

PSI 9 080 - 510 3U zzz

zzz	Field for identification of installed options and/or special models **3W** = Option 3W installed (GPIB port instead of Anybus slot) **HS** = High Speed option installed **WC** = Water cooling installed
3U	Construction (not always given) **2U / 3U / 4U** = 19" frame with 2U, 3U or 4U **T** = "Tower" - vertical standing model **DT** = "Desktop" model **R** = "Rack mount" model in frame for wall mounting
510	Maximum current of the device in Ampere
080	Maximum voltage of the device in Volt
9	Series : **8** = Series 8000 or 800, **9** = Series 9000
PSI	Type identification: **PS** = Power Supply, usually programmable **PSI** = Power Supply Intelligent, always programmable **ELR** = Electronic Load with Recovery

Special models are always derived from standard models and can vary in input voltage and current from those given.

1.6 Intended usage

The equipment is intended to be used, if a power supply or battery charger, only as a variable voltage and current source, or, if an electronic load, only as a variable current sink.

Typical application for a power supply is DC supply to any relevant user, for a battery charger the charging of various battery types and for electronic loads the replacement of an ohmic resistor by an adjustable DC current sink in order to load relevant voltage and current sources of any type.

- Claims of any sort due to damage caused by non-intended usage will not be accepted.
- All damage caused by non-intended usage is solely the responsibility of the operator.

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1.7 Safety

1.7.1 Safety notices

Mortal danger - Hazardous voltage

- **Electrical equipment operation means that some parts can be under dangerous voltage. Therefore all parts under voltage must be covered! This basically applies to all models, though 40 V models according to SELV can't generate hazardous DC voltage.**
- **All work on connections must be carried out under zero voltage (output not connected to load) and may only be performed by qualified and informed persons. Improper actions can cause fatal injury as well as serious material damage.**
- **Never touch cables or connectors directly after unplugging from mains supply as the danger of electric shock remains!**
- **Never touch the contacts on DC output terminal directly after switching off the DC output, because there still can dangerous voltage present, sinking more or less slowly depending on the load! There also can be dangerous potential between negative DC output to PE or positive DC output to PE due to charged X capacitors.**

- The equipment must only be used as intended
- The equipment is only approved for use within the connection limits stated on the product label.
- Do not insert any object, particularly metallic, through the ventilator slots
- Avoid any use of liquids near the equipment. Protect the device from wet, damp and condensation.
- For power supplies and battery chargers: do not connect users, particularly low resistance, to devices under power; sparking may occur which can cause burns as well as damage to the equipment and to the user.
- For electronic loads: do not connect power sources to equipment under power, sparking may occur which can cause burns as well as damage to the equipment and to the source.
- ESD regulations must be applied when plugging interface cards or modules into the relative slot
- Interface cards or modules may only be attached or removed after the device is switched off. It is not necessary to open the device.
- Do not connect external power sources with reversed polarity to DC input or outputs! The equipment will be damaged.
- For power supply devices: avoid where possible connecting external power sources to the DC output, and never those that can generate a higher voltage than the nominal voltage of the device.
- For electronic loads: do not connect a power source to the DC input which can generate a voltage more than 120% of the nominal input voltage of the load. The equipment is not protected against over voltage and may be irreparably damaged.
- Never insert a network cable which is connected to Ethernet or its components into the master-slave socket on the back side of the device!

1.7.2 Responsibility of the user

The equipment is in industrial operation. Therefore the operators are governed by the legal safety regulations. Alongside the warning and safety notices in this manual the relevant safety, accident prevention and environmental regulations must also be applied. In particular the users of the equipment:

- must be informed of the relevant job safety requirements
- must work to the defined responsibilities for operation, maintenance and cleaning of the equipment
- before starting work must have read and understood the operating manual
- must use the designated and recommended safety equipment.

Furthermore, anyone working with the equipment is responsible for ensuring that the device is at all times technically fit for use.

1.7.3 Responsibility of the operator

Operator is any natural or legal person who uses the equipment or delegates the usage to a third party, and is responsible during its usage for the safety of the user, other personnel or third parties.

The equipment is in industrial operation. Therefore the operators are governed by the legal safety regulations. Alongside the warning and safety notices in this manual the relevant safety, accident prevention and environmental regulations must also be applied. In particular the operator has to

- be acquainted with the relevant job safety requirements
- identify other possible dangers arising from the specific usage conditions at the work station via a risk assessment
- introduce the necessary steps in the operating procedures for the local conditions
- regularly control that the operating procedures are current
- update the operating procedures where necessary to reflect changes in regulation, standards or operating conditions.
- define clearly and unambiguously the responsibilities for operation, maintenance and cleaning of the equipment.
- ensure that all employees who use the equipment have read and understood the manual. Furthermore the users are to be regularly schooled in working with the equipment and the possible dangers.
- provide all personnel who work with the equipment with the designated and recommended safety equipment

Furthermore, the operator is responsible for ensuring that the device is at all times technically fit for use.

1.7.4 User requirements

Any activity with equipment of this type may only be performed by persons who are able to work correctly and reliably and satisfy the requirements of the job.

- Persons whose reaction capability is negatively influenced by e.g. drugs, alcohol or medication may not operate the equipment.
- Age or job related regulations valid at the operating site must always be applied.

Danger for unqualified users

Improper operation can cause person or object damage. Only persons who have the necessary training, knowledge and experience may use the equipment.

Delegated persons are those who have been properly and demonstrably instructed in their tasks and the attendant dangers.

Qualified persons are those who are able through training, knowledge and experience as well as knowledge of the specific details to carry out all the required tasks, identify dangers and avoid personal and other risks.

All work on electrical equipment may only be performed by qualified electricians.

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1.7.5 Alarm signals

The equipment offers various possibilities for signalling alarm conditions, however, not for danger situations. The signals may be optical (on the display as text), acoustic (piezo buzzer) or electronic (pin/status output of an analog interface). All alarms will cause the device to switch off the DC output.

The meaning of the signals is as follows:

Signal **OT** (OverTemperature)	• Overheating of the device • DC output will be switched off • Non-critical
Signal **OVP** (OverVoltage)	• Overvoltage shutdown of the DC output due to high voltage entering the device or generated by the device itself due to a defect • Critical! The device and/or the load could be damaged
Signal **OCP** (OverCurrent)	• Shutdown of the DC output due to excess of the preset limit • Non-critical, protects the load from excessive current consumption
Signal **OPP** (OverPower)	• Shutdown of the DC output due to excess of the preset limit • Non-critical, protects the load from excessive power consumption
Signal **PF** (Power Fail)	• DC output shutdown due to AC undervoltage or defect in the AC input • Critical on overvoltage! AC input circuit could be damaged

1.8 Technical Data

1.8.1 Approved operating conditions

- Use only inside dry buildings
- Ambient temperature 0-50°C
- Operational altitude: max. 2000 m above sea level
- Max 80% RH up to 30°C, linear decrease to 50% RH at 50°C

1.8.2 General technical data

Display: Colour TFT touch screen with gorilla glass, 4.3”, 480pt x 272pt, capacitive

Controls: 2 rotary knobs with pushbutton function, 1 pushbutton

The nominal values for the device determine the maximum adjustable ranges.

1.8.3 Specific technical data

3.3 kW / 5 kW	Model 3U				
	PSI 9040-170	PSI 9080-170	PSI 9200-70	PSI 9360-40	PSI 9500-30
AC Input					
Voltage L-L (400 V models)	340...460 V AC	340...460 V AC	340...460 V AC	340...460 V AC	340...460 V AC
Voltage L-L (208 V models)	187...229 V AC	187...229 V AC	187...229 V AC	187...229 V AC	187...229 V AC
Connection	2ph,PE	2ph,PE	2ph,PE	2ph,PE	2ph,PE
Frequency range	45 - 65 Hz	45 - 65 Hz	45 - 65 Hz	45 - 65 Hz	45 - 65 Hz
Fusing (internal) (400 V models)	2x T16 A	2x T16 A	2x T16 A	2x T16 A	2x T16 A
Fusing (internal) (208 V models)	2x T32 A	2x T32 A	2x T32 A	2x T32 A	2x T32 A
Leak current	< 3.5 mA	< 3.5 mA	< 3.5 mA	< 3.5 mA	< 3.5 mA
Power factor	> 0.99	> 0.99	> 0.99	> 0.99	> 0.99
DC Output					
Max. output voltage U_{Max}	40 V	80 V	200 V	360 V	500 V
Max. output current I_{Max}	170 A	170 A	70 A	40 A	30 A
Max. output power P_{Max}	3.3 kW	5 kW	5 kW	5 kW	5 kW
Overvoltage protection range	0...44 V	0...88 V	0...220 V	0...396 V	0...550 V
Overcurrent protection range	0...187 A	0...187 A	0...77 A	0...44 A	0...33 A
Overpower protection range	0…3.63 kW	0…5.50 kW	0…5.50 kW	0…5.50 kW	0…5.50 kW
Temperature coefficient for set values Δ/K	Voltage / current: 100 ppm				
Voltage regulation					
Adjustment range	0...40 V	0...80 V	0...200 V	0...360 V	0...500 V
Accuracy (1 (at 23 ± 5°C)	< 0.1% U_{Max}	< 0.1% U_{Max}	< 0.1% U_{Max}	< 0.1% U_{Max}	< 0.1% U_{Max}
Line regulation at ±10% ΔU_{AC}	< 0.02% U_{Max}	< 0.02% U_{Max}	< 0.02% U_{Max}	< 0.02% U_{Max}	< 0.02% U_{Max}
Load regulation at 0...100% load	< 0.05% U_{Max}	< 0.05% U_{Max}	< 0.05% U_{Max}	< 0.05% U_{Max}	< 0.05% U_{Max}
Rise time 10...90% ΔU	Max. 15 ms	Max. 15 ms	Max. 15 ms	Max. 15 ms	Max. 15 ms
Transient time after load step	< 1.5 ms	< 1.5 ms	< 1.5 ms	< 1.5 ms	< 1.5 ms
Display: Resolution	See section *"1.9.6.4. Resolution of the displayed values"*				
Display: Accuracy (4	≤ 0.2% U_{Max}	≤ 0.2% U_{Max}	≤ 0.2% U_{Max}	≤ 0.2% U_{Max}	≤ 0.2% U_{Max}
Ripple (2	< 200 mV_{PP} < 16 mV_{RMS}	< 200 mV_{PP} < 16 mV_{RMS}	< 300 mV_{PP} < 40 mV_{RMS}	< 320 mV_{PP} < 55 mV_{RMS}	< 350 mV_{PP} < 70 mV_{RMS}
Remote sensing compensation	Max. 5% U_{Max}	Max. 5% U_{Max}	Max. 5% U_{Max}	Max. 5% U_{Max}	Max. 5% U_{Max}
Fall time at no load after switching DC output off	-	Down from 100% to <60 V: less than 10 s			
Current regulation					
Adjustment range	0...170 A	0...170 A	0...70 A	0...40 A	0...30 A
Accuracy (1 (at 23 ± 5°C)	< 0.2% I_{Max}	< 0.2% I_{Max}	< 0.2% I_{Max}	< 0.2% I_{Max}	< 0.2% I_{Max}
Line regulation at ±10% ΔU_{AC}	< 0.05% I_{Max}	< 0.05% I_{Max}	< 0.05% I_{Max}	< 0.05% I_{Max}	< 0.05% I_{Max}
Load regulation at 0...100% ΔU_{OUT}	< 0.15% I_{Max}	< 0.15% I_{Max}	< 0.15% I_{Max}	< 0.15% I_{Max}	< 0.15% I_{Max}
Ripple (2	< 80 mA_{RMS}	< 80 mA_{RMS}	< 22 mA_{RMS}	< 18 mA_{RMS}	< 16 mA_{RMS}
Display: Resolution	See section *"1.9.6.4. Resolution of the displayed values"*				
Display: Accuracy (4	≤ 0.2% I_{Max}	≤ 0.2% I_{Max}	≤ 0.2% I_{Max}	≤ 0.2% I_{Max}	≤ 0.2% I_{Max}
Power regulation					
Adjustment range	0…3.30 kW	0…5.00 kW	0…5.00 kW	0…5.00 kW	0…5.00 kW
Accuracy (1 (at 23 ± 5°C)	< 1% P_{Max}	< 1% P_{Max}	< 1% P_{Max}	< 1% P_{Max}	< 1% P_{Max}
Line regulation at ±10% ΔU_{AC}	< 0.05% P_{Max}	< 0.05% P_{Max}	< 0.05% P_{Max}	< 0.05% P_{Max}	< 0.05% P_{Max}
Load reg. at 10-90% ΔU_{OUT} * ΔI_{OUT}	< 0.75% P_{Max}	< 0.75% P_{Max}	< 0.75% P_{Max}	< 0.75% P_{Max}	< 0.75% P_{Max}

(1 Related to the nominal values, the accuracy defines the maximum deviation between an adjusted values and the true (actual) value.
Example: a 80 V model has min. 0.1% voltage accuracy, that is 80 mV. When adjusting the voltage to 5 V, the actual value is allowed to differ max. 80 mV, which means it might be between 4.92 V and 5.08 V.

(2 RMS value: LF 0...300 kHz, PP value: HF 0...20MHz
(3 Typical value at 100% output voltage and 100% power
(4 The display error adds to the error of the related actual value on the DC output

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3.3 kW / 5 kW	Model 3U				
	PSI 9040-170	PSI 9080-170	PSI 9200-70	PSI 9360-40	PSI 9500-30
Power regulation					
Display: Resolution	See section *"1.9.6.4. Resolution of the displayed values"*				
Display: Accuracy (2	≤ 0.75% P_{Max}	≤ 0.8% P_{Max}	≤ 0.8% P_{Max}	≤ 0.8% P_{Max}	≤ 0.8% P_{Max}
Efficiency (6	~ 93%	~ 93%	~ 95%	~ 95%	~ 95,5%
Internal resistance regulation					
Adjustment range	0...7 Ω	0...14 Ω	0...85 Ω	0...270 Ω	0...500 Ω
Accuracy (1	≤2% of max. resistance ± 0.3% of maximum current				
Display: Resolution	See section *"1.9.6.4. Resolution of the displayed values"*				
Display: Accuracy (2	≤0.4%	≤0.4%	≤0.4%	≤0.4%	≤0.4%
Analog interface (3					
Set value inputs	U, I, P	U, I, P	U, I, P	U, I, P	U, I, P
Actual value output	U, I	U, I	U, I	U, I	U, I
Control signals	DC on/off, Remote on/off	DC on/off, Remote on/off	DC on/off, Remote on/off	DC on/off, Remote on/off	DC on/off, Remote on/off
Status signals	CV, OVP, OT	CV, OVP, OT	**CV, OVP, OT**	CV, OVP, OT	CV, OVP, OT
Galvanic isolation to the device	Max. 1500 V DC	Max. 1500 V DC	Max. 1500 V DC	Max. 1500 V DC	Max. 1500 V DC
Insulation (4	Allowed float (potential shift) on the DC output:				
Negative terminal to PE	±400 V DC	±400 V DC	±400 V DC	±400 V DC	±725 V DC
Positive terminal to PE	+400 V DC	+400 V DC	+600 V DC	+600 V DC	+1000 V DC
Miscellaneous					
Cooling	Temperature controlled fans, front inlet, rear exhaust				
Ambient temperature	0..50°C				
Storage temperature	-20...70°C				
Humidity	< 80%, not condensing				
Standards	EN 61010, EN 61326 EMC TÜV approved acc. IEC 61000-6-2:2005 and IEC 61000-6-3:2006 Class B				
Overvoltage category	2				
Protection class	1				
Pollution degree	2				
Operational altitude	< 2000 m				
Digital interfaces					
Featured	1x USB-B for communication, 1x USB-A for functions, 1x GPIB (optional)				
Slot (standard version)	optional: CANopen, Profibus, Profinet, RS232, Devicenet, Ethernet, ModBus				
Galvanic isolation from device	Max. 1500 V DC				
Terminals					
Rear side	Share Bus, DC output, AC input, remote sensing, analog interface, USB-B, master-slave bus, AnyBus module slot				
Front side	USB-A				
Dimensions					
Enclosure (WxHxD)	19" x 3U x 609 mm				
Total (WxHxD)	483 x 133 x 714 mm				
Weight	~ 17 kg	~ 17 kg	~ 17 kg	~ 17 kg	~ 17 kg
Article number (400 V model) (5	06230350	06230351	06230352	06230353	06230354
Article number (208 V model) (5	upon request	upon request	upon request	upon request	upon request

(1 Related to the nominal values, the accuracy defines the maximum deviation between an adjusted values and the true (actual) value
(2 The display error adds to the error of the related actual value on the DC output
(3 For technical specifications of the analog interface see *"3.5.4.3 Analog interface specification" on page 52*
(4 All values valid for devices manufactured after 1st of July 2014
(5 Article number of the standard version, devices with options will have a different number
(6 Typical value at 100% output voltage and 100% power

5 kW / 6.6 kW / 10 kW	Model 3U				
	PSI 9750-20	PSI 9040-340	PSI 9040-510	PSI 9080-340	PSI 9200-140
AC Input					
Voltage L-L (400 V models)	340...460 V AC	340...460 V AC	340...460 V AC	340...460 V AC	340...460 V AC
Voltage L-L (208 V models)	187...229 V AC	187...229 V AC	187...229 V AC	187...229 V AC	187...229 V AC
Connection	2ph,PE	3ph,PE	3ph,PE	3ph,PE	3ph,PE
Frequency range	45 - 65 Hz	45 - 65 Hz	45 - 65 Hz	45 - 65 Hz	45 - 65 Hz
Fusing (internal) (400 V models)	2x T16 A	4x T16 A	6x T16 A	4x T16 A	4x T16 A
Fusing (internal) (208 V models)	2x T32 A	4x T32 A	6x T32 A	4x T32 A	4x T32 A
Leak current	< 3.5 mA	< 3.5 mA	< 3.5 mA	< 3.5 mA	< 3.5 mA
Power factor	> 0.99	> 0.99	> 0.99	> 0.99	> 0.99
DC Output					
Max. output voltage U_{Max}	750 V	40 V	40 V	80 V	200 V
Max. output current I_{Max}	20 A	340 A	510 A	340 A	140 A
Max. output power P_{Max}	5 kW	6.6 kW	10 kW	10 kW	10 kW
Overvoltage protection range	0...825 V	0...44 V	0...44 V	0...88 V	0...220 V
Overcurrent protection range	0...22 A	0...374 A	0...561 A	0...374 A	0...154 A
Overpower protection range	0…5.50 kW	0…7.26 kW	0…11.00 kW	0…11.00 kW	0…11.00 kW
Temperature coefficient for set values Δ/K	Voltage / current: 100 ppm				
Voltage regulation					
Adjustment range	0...750 V	0...40 V	0...40 V	0...80 V	0...200 V
Accuracy (1 (at 23 ± 5°C)	< 0.1% U_{Max}	< 0.1% U_{Max}	< 0.1% U_{Max}	< 0.1% U_{Max}	< 0.1% U_{Max}
Line regulation at ±10% ΔU_{AC}	< 0.02% U_{Max}	< 0.02% U_{Max}	< 0.02% U_{Max}	< 0.02% U_{Max}	< 0.02% U_{Max}
Load regulation at 0...100% load	< 0.05% U_{Max}	< 0.05% U_{Max}	< 0.05% U_{Max}	< 0.05% U_{Max}	< 0.05% U_{Max}
Rise time 10...90% ΔU	Max. 15 ms	Max. 15 ms	Max. 15 ms	Max. 15 ms	Max. 15 ms
Transient time after load step	< 1.5 ms	< 1.5 ms	< 1.5 ms	< 1.5 ms	< 1.5 ms
Display: Resolution	See section *"1.9.6.4. Resolution of the displayed values"*				
Display: Accuracy (4	≤ 0.2% U_{Max}	≤ 0.2% U_{Max}	≤ 0.2% U_{Max}	≤ 0.2% U_{Max}	≤ 0.2% U_{Max}
Ripple (2	< 800 mV_{PP} < 200 mV_{RMS}	< 320 mV_{PP} < 25 mV_{RMS}	< 320 mV_{PP} < 25 mV_{RMS}	< 320 mV_{PP} < 25 mV_{RMS}	< 300 mV_{PP} < 40 mV_{RMS}
Remote sensing compensation	Max. 5% U_{Max}	Max. 5% U_{Max}	Max. 5% U_{Max}	Max. 5% U_{Max}	Max. 5% U_{Max}
Fall time at no load after switching DC output off	Down from 100% to <60 V: less than 10 s	-	-	Down from 100% to <60 V: less than 10 s	Down from 100% to <60 V: less than 10 s
Current regulation					
Adjustment range	0...20 A	0...340 A	0...510 A	0...340 A	0...140 A
Accuracy (1 (at 23 ± 5°C)	< 0.2% I_{Max}	< 0.2% I_{Max}	< 0.2% I_{Max}	< 0.2% I_{Max}	< 0.2% I_{Max}
Line regulation at ±10% ΔU_{AC}	< 0.05% I_{Max}	< 0.05% I_{Max}	< 0.05% I_{Max}	< 0.05% I_{Max}	< 0.05% I_{Max}
Load regulation at 0...100% ΔU_{OUT}	< 0.15% I_{Max}	< 0.15% I_{Max}	< 0.15% I_{Max}	< 0.15% I_{Max}	< 0.15% I_{Max}
Ripple (2	< 16 mA_{RMS}	< 160 mA_{RMS}	< 120 mA_{RMS}	< 160 mA_{RMS}	< 44 mA_{RMS}
Display: Resolution	See section *"1.9.6.4. Resolution of the displayed values"*				
Display: Accuracy (4	≤ 0.2% I_{Max}	≤ 0.2% I_{Max}	≤ 0.2% I_{Max}	≤ 0.2% I_{Max}	≤ 0.2% I_{Max}
Power regulation					
Adjustment range	0…5.00 kW	0…6.60 kW	0…10.00 kW	0…10.00 kW	0…10.00 kW
Accuracy (1 (at 23 ± 5°C)	< 1% P_{Max}	< 1% P_{Max}	< 1% P_{Max}	< 1% P_{Max}	< 1% P_{Max}
Line regulation at ±10% ΔU_{AC}	< 0.05% P_{Max}	< 0.05% P_{Max}	< 0.05% P_{Max}	< 0.05% P_{Max}	< 0.05% P_{Max}
Load reg. at 10-90% ΔU_{OUT} * ΔI_{OUT}	< 0.75% P_{Max}	< 0.75% P_{Max}	< 0.75% P_{Max}	< 0.75% P_{Max}	< 0.75% P_{Max}

(1 Related to the nominal values, the accuracy defines the maximum deviation between an adjusted values and the true (actual) value.
Example: a 80 V model has min. 0.1% voltage accuracy, that is 80 mV. When adjusting the voltage to 5 V, the actual value is allowed to differ max. 80 mV, which means it might be between 4.92 V and 5.08 V.
(2 RMS value: LF 0...300 kHz, PP value: HF 0...20MHz
(3 Typical value at 100% output voltage and 100% power
(4 The display error adds to the error of the related actual value on the DC output.

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5 kW / 6.6 kW / 10 kW	Model 3U				
	PSI 9750-20	PSI 9040-340	PSI 9040-510	PSI 9080-340	PSI 9200-140
Power regulation					
Display: Resolution	See section *"1.9.6.4. Resolution of the displayed values"*				
Display: Accuracy (2	≤ 0.8% P_{Max}	≤ 0.7% P_{Max}	≤ 0.7% P_{Max}	≤ 0.8% P_{Max}	≤ 0.85% P_{Max}
Efficiency (6	~ 94%	~ 93%	~ 93%	~ 93%	~ 95%
Internal resistance regulation					
Adjustment range	0...1125 Ω	0...3,5 Ω	0...2 Ω	0...7 Ω	0...42 Ω
Accuracy (1	≤2% of max. resistance ± 0.3% of maximum current				
Display: Resolution	See section *"1.9.6.4. Resolution of the displayed values"*				
Display: Accuracy (2	≤ 0.4%	≤ 0.4%	≤ 0.4%	≤ 0.4%	≤ 0.4%
Analog interface (3					
Set value inputs	U, I, P	U, I, P	U, I, P	U, I, P	U, I, P
Actual value output	U, I	U, I	U, I	U, I	U, I
Control signals	DC on/off, Remote on/off	DC on/off, Remote on/off	DC on/off, Remote on/off	DC on/off, Remote on/off	DC on/off, Remote on/off
Status signals	CV, OVP, OT	CV, OVP, OT	CV, OVP, OT	CV, OVP, OT	CV, OVP, OT
Galvanic isolation to the device	Max. 1500 V DC	Max. 1500 V DC	Max. 1500 V DC	Max. 1500 V DC	Max. 1500 V DC
Insulation (4	Allowed float (potential shift) on the DC output:				
Negative terminal to PE	±725 V DC	±400 V DC	±400 V DC	±400 V DC	±400 V DC
Positive terminal to PE	+1000 V DC	±400 V DC	±400 V DC	±400 V DC	+600 V DC
Miscellaneous					
Cooling	Temperature controlled fans, front inlet, rear exhaust				
Ambient temperature	0..50°C				
Storage temperature	-20...70°C				
Humidity	< 80%, not condensing				
Standards	EN 61010, EN 61326 EMC TÜV approved acc. IEC 61000-6-2:2005 and IEC 61000-6-3:2006 Class B				
Overvoltage category	2				
Protection class	1				
Pollution degree	2				
Operational altitude	< 2000 m				
Digital interfaces					
Featured	1x USB-B for communication, 1x USB-A for functions, 1x GPIB (optional)				
Slot (standard version)	optional: CANopen, Profibus, Profinet, RS232, Devicenet, Ethernet, ModBus				
Galvanic isolation from device	Max. 1500 V DC				
Terminals					
Rear side	Share Bus, DC output, AC input, remote sensing, analog interface, USB-B, master-slave bus, AnyBus module slot				
Front side	USB-A				
Dimensions					
Enclosure (WxHxD)	19" x 3U x 609 mm				
Total (WxHxD)	483 x 133 x 714 mm				
Weight	~ 17 kg	~ 24 kg	~ 30 kg	~ 24 kg	~ 24 kg
Article number (400 V model) (5	06230355	06230356	06230363	06230357	06230358
Article number (208 V model) (5	upon request	upon request	upon request	upon request	upon request

(1 Related to the nominal values, the accuracy defines the maximum deviation between an adjusted values and the true (actual) value
(2 The display error adds to the error of the related actual value on the DC output
(3 For technical specifications of the analog interface see *"3.5.4.3 Analog interface specification" on page 52*
(4 All values valid for devices manufactured after 1st of July 2014
(5 Article number of the standard version, devices with options will have a different number
(6 Typical value at 100% output voltage and 100% power

10 kW / 15 kW	Model 3U				
	PSI 9360-80	PSI 9500-60	PSI 9750-40	PSI 91000-30	PSI 9080-510
AC Input					
Voltage L-L (400 V models)	340...460 V AC	340...460 V AC	340...460 V AC	340...460 V AC	340...460 V AC
Voltage L-L (208 V models)	187...229 V AC	187...229 V AC	187...229 V AC	187...229 V AC	187...229 V AC
Connection	3ph,PE	3ph,PE	3ph,PE	3ph,PE	3ph,PE
Frequency range	45 - 65 Hz	45 - 65 Hz	45 - 65 Hz	45 - 65 Hz	45 - 65 Hz
Fusing (internal) (400 V models)	4x T16 A	4x T16 A	4x T16 A	4x T16 A	6x T16 A
Fusing (internal) (208 V models)	4x T32 A	4x T32 A	4x T32 A	4x T32 A	6x T32 A
Leak current	< 3.5 mA	< 3.5 mA	< 3.5 mA	< 3.5 mA	< 3.5 mA
Power factor	> 0.99	> 0.99	> 0.99	> 0.99	> 0.99
DC Output					
Max. output voltage U_{Max}	360 V	500 V	750 V	1000 V	80 V
Max. output current I_{Max}	80 A	60 A	40 A	30 A	510 A
Max. output power P_{Max}	10 kW	10 kW	10 kW	10 kW	15 kW
Overvoltage protection range	0...396 V	0...550 V	0...825 V	0...1100 V	0...88 V
Overcurrent protection range	0...88 A	0...66 A	0...44 A	0...33 A	0...561 A
Overpower protection range	0…11.00 kW	0…11.00 kW	0…11.00 kW	0…11.00 kW	0…16.50 kW
Temperature coefficient for set values Δ/K	Voltage / current: 100 ppm				
Voltage regulation					
Adjustment range	0...360 V	0...500 V	0...750 V	0...1000 V	0...80 V
Accuracy (1 (at 23 ± 5°C)	< 0.1% U_{Max}	< 0.1% U_{Max}	< 0.1% U_{Max}	< 0.1% U_{Max}	< 0.1% U_{Max}
Line regulation at ±10% ΔU_{AC}	< 0.02% U_{Max}	< 0.02% U_{Max}	< 0.02% U_{Max}	< 0.02% U_{Max}	< 0.02% U_{Max}
Load regulation at 0...100% load	< 0.05% U_{Max}	< 0.05% U_{Max}	< 0.05% U_{Max}	< 0.05% U_{Max}	< 0.05% U_{Max}
Rise time 10...90% ΔU	Max. 15 ms	Max. 15 ms	Max. 15 ms	Max. 15 ms	Max. 15 ms
Transient time after load step	< 1.5 ms	< 1.5 ms	< 1.5 ms	< 1.5 ms	< 1.5 ms
Display: Resolution	See section *"1.9.6.4. Resolution of the displayed values"*				
Display: Accuracy (4	≤ 0.2% U_{Max}	≤ 0.2% U_{Max}	≤ 0.2% U_{Max}	≤ 0.2% U_{Max}	≤ 0.2% U_{Max}
Ripple (2	< 320 mV_{PP} < 55 mV_{RMS}	< 350 mV_{PP} < 70 mV_{RMS}	< 800 mV_{PP} < 200 mV_{RMS}	< 1600 mV_{PP} < 350 mV_{RMS}	< 320 mV_{PP} < 25 mV_{RMS}
Remote sensing compensation	Max. 5% U_{Max}	Max. 5% U_{Max}	Max. 5% U_{Max}	Max. 5% U_{Max}	Max. 5% U_{Max}
Fall time at no load after switching DC output off	Down from 100% to <60 V: less than 10 s				
Current regulation					
Adjustment range	0...80 A	0...60 A	0...40 A	0...30 A	0...510 A
Accuracy (1 (at 23 ± 5°C)	< 0.2% I_{Max}	< 0.2% I_{Max}	< 0.2% I_{Max}	< 0.2% I_{Max}	< 0.2% I_{Max}
Line regulation at ±10% ΔU_{AC}	< 0.05% I_{Max}	< 0.05% I_{Max}	< 0.05% I_{Max}	< 0.05% I_{Max}	< 0.05% I_{Max}
Load regulation at 0...100% ΔU_{OUT}	< 0.15% I_{Max}	< 0.15% I_{Max}	< 0.15% I_{Max}	< 0.15% I_{Max}	< 0.15% I_{Max}
Ripple (2	< 35 mA_{RMS}	< 32 mA_{RMS}	< 32 mA_{RMS}	< 22 mA_{RMS}	< 240 mA_{RMS}
Display: Resolution	See section *"1.9.6.4. Resolution of the displayed values"*				
Display: Accuracy (4	≤ 0.2% I_{Max}	≤ 0.2% I_{Max}	≤ 0.2% I_{Max}	≤ 0.2% I_{Max}	≤ 0.2% I_{Max}
Power regulation					
Adjustment range	0…10.00 kW	0…10.00 kW	0…10.00 kW	0…10.00 kW	0…15.00 kW
Accuracy (1 (at 23 ± 5°C)	< 1.2% P_{Max}	< 1.2% P_{Max}	< 1.2% P_{Max}	< 1.2% P_{Max}	< 1.2% P_{Max}
Line regulation at ±10% ΔU_{AC}	< 0.05% P_{Max}	< 0.05% P_{Max}	< 0.05% P_{Max}	< 0.05% P_{Max}	< 0.05% P_{Max}
Load reg. at 10-90% ΔU_{OUT} * ΔI_{OUT}	< 0.75% P_{Max}	< 0.75% P_{Max}	< 0.75% P_{Max}	< 0.75% P_{Max}	< 0.75% P_{Max}

(1 Related to the nominal values, the accuracy defines the maximum deviation between an adjusted values and the true (actual) value.
Example: a 80 V model has min. 0.1% voltage accuracy, that is 80 mV. When adjusting the voltage to 5 V, the actual value is allowed to differ max. 80 mV, which means it might be between 4.92 V and 5.08 V.
(2 RMS value: LF 0...300 kHz, PP value: HF 0...20MHz
(3 Typical value at 100% output voltage and 100% power
(4 The display error adds to the error of the related actual value on the DC output.

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10 kW / 15 kW	Model 3U				
	PSI 9360-80	PSI 9500-60	PSI 9750-40	PSI 91000-30	PSI 9080-510
Power regulation					
Display: Resolution	See section *"1.9.6.4. Resolution of the displayed values"*				
Display: Accuracy (2	≤ 0.8% P_{Max}	≤ 0.85% P_{Max}	≤ 0.85% P_{Max}	≤ 0.85% P_{Max}	≤ 0.8% P_{Max}
Efficiency (6	~ 93%	~ 95%	~ 94%	~ 95%	~ 93%
Internal resistance regulation					
Adjustment range	0...135 Ω	0...250 Ω	0...562 Ω	0...1000 Ω	0...5 Ω
Accuracy (1	≤ 2% of max. resistance ± 0.3% of maximum current				
Display: Resolution	See section *"1.9.6.4. Resolution of the displayed values"*				
Display: Accuracy (2	≤ 0.4%	≤ 0.4%	≤ 0.4%	≤ 0.4%	≤ 0.4%
Analog interface (3					
Set value inputs	U, I, P	U, I, P	U, I, P	U, I, P	U, I, P
Actual value output	U, I	U, I	U, I	U, I	U, I
Control signals	DC on/off, Remote on/off	DC on/off, Remote on/off	DC on/off, Remote on/off	DC on/off, Remote on/off	DC on/off, Remote on/off
Status signals	CV, OVP, OT	CV, OVP, OT	CV, OVP, OT	CV, OVP, OT	CV, OVP, OT
Galvanic isolation to the device	Max. 1500 V DC	Max. 1500 V DC	Max. 1500 V DC	Max. 1500 V DC	Max. 1500 V DC
Insulation (4	Allowed float (potential shift) on the DC output:				
Negative terminal to PE	±400 V DC	±725 V DC	±725 V DC	±1000 V DC	±400 V DC
Positive terminal to PE	+600 V DC	+1000 V DC	+1000 V DC	+1500 V DC	±400 V DC
Miscellaneous					
Cooling	Temperature controlled fans, front inlet, rear exhaust				
Ambient temperature	0..50°C				
Storage temperature	-20...70°C				
Humidity	< 80%, not condensing				
Standards	EN 61010, EN 61326 EMC TÜV approved acc. IEC 61000-6-2:2005 and IEC 61000-6-3:2006 Class B				
Overvoltage category	2				
Protection class	1				
Pollution degree	2				
Operational altitude	< 2000 m				
Digital interfaces					
Featured	1x USB-B for communication, 1x USB-A for functions, 1x GPIB (optional)				
Slot (standard version)	optional: CANopen, Profibus, Profinet, RS232, Devicenet, Ethernet, ModBus				
Galvanic isolation from device	Max. 1500 V DC				
Terminals					
Rear side	Share Bus, DC output, AC input, remote sensing, analog interface, USB-B, master-slave bus, AnyBus module slot				
Front side	USB-A				
Dimensions					
Enclosure (WxHxD)	19" x 3U x 609 mm				
Total (WxHxD)	483 x 133 x 714 mm				
Weight	~ 24 kg	~ 24 kg	~ 24 kg	~ 24 kg	~ 30 kg
Article number (400 V model) (5	06230359	06230360	06230361	06230362	06230364
Article number (208 V model) (5	upon request	upon request	upon request	upon request	upon request

(1 Related to the nominal values, the accuracy defines the maximum deviation between an adjusted values and the true (actual) value
(2 The display error adds to the error of the related actual value on the DC output
(3 For technical specifications of the analog interface see *"3.5.4.3 Analog interface specification" on page 52*
(4 All values valid for devices manufactured after 1st of July 2014
(5 Article number of the standard version, devices with options will have a different number
(6 Typical value at 100% output voltage and 100% power

15 kW	Model 3U				
	PSI 9200-210	PSI 9360-120	PSI 9500-90	PSI 9750-60	PSI 91500-30
AC Input					
Voltage L-L (400 V models)	340...460 V AC	340...460 V AC	340...460 V AC	340...460 V AC	340...460 V AC
Voltage L-L (208 V models)	187...229 V AC	187...229 V AC	187...229 V AC	187...229 V AC	187...229 V AC
Connection	3ph,PE	3ph,PE	3ph,PE	3ph,PE	3ph,PE
Frequency range	45 - 65 Hz	45 - 65 Hz	45 - 65 Hz	45 - 65 Hz	45 - 65 Hz
Fusing (internal) (400 V models)	6x T16 A	6x T16 A	6x T16 A	6x T16 A	6x T16 A
Fusing (internal) (208 V models)	6x T32 A	6x T32 A	6x T32 A	6x T32 A	6x T32 A
Leak current	< 3.5 mA	< 3.5 mA	< 3.5 mA	< 3.5 mA	< 3.5 mA
Power factor	> 0.99	> 0.99	> 0.99	> 0.99	> 0.99
DC Output					
Max. output voltage U_{Max}	200 V	360 V	500 V	750 V	1500 V
Max. output current I_{Max}	210 A	120 A	90 A	60 A	30 A
Max. output power P_{Max}	15 kW	15 kW	15 kW	15 kW	15 kW
Overvoltage protection range	0...220 V	0...396 V	0...550 V	0...825 V	0...1650 V
Overcurrent protection range	0...231 A	0...132 A	0...99 A	0...66 A	0...33 A
Overpower protection range	0…16.50 kW	0…16.50 kW	0…16.50 kW	0…16.50 kW	0…16.50 kW
Temperature coefficient for set values Δ/K	Voltage / current: 100 ppm				
Voltage regulation					
Adjustment range	0...200 V	0...360 V	0...500 V	0...750 V	0...1500 V
Accuracy (1 (at 23 ± 5°C)	< 0.1% U_{Max}	< 0.1% U_{Max}	< 0.1% U_{Max}	< 0.1% U_{Max}	< 0.1% U_{Max}
Line regulation at ±10% ΔU_{AC}	< 0.02% U_{Max}	< 0.02% U_{Max}	< 0.02% U_{Max}	< 0.02% U_{Max}	< 0.02% U_{Max}
Load regulation at 0...100% load	< 0.05% U_{Max}	< 0.05% U_{Max}	< 0.05% U_{Max}	< 0.05% U_{Max}	< 0.05% U_{Max}
Rise time 10...90% ΔU	Max. 15 ms	Max. 15 ms	Max. 15 ms	Max. 15 ms	Max. 15 ms
Transient time after load step	< 1.5 ms	< 1.5 ms	< 1.5 ms	< 1.5 ms	< 1.5 ms
Display: Resolution	See section *"1.9.6.4. Resolution of the displayed values"*				
Display: Accuracy (4	≤ 0.2% U_{Max}	≤ 0.2% U_{Max}	≤ 0.2% U_{Max}	≤ 0.2% U_{Max}	≤ 0.2% U_{Max}
Ripple (2	< 300 mV_{PP} < 40 mV_{RMS}	< 320 mV_{PP} < 55 mV_{RMS}	< 350 mV_{PP} < 70 mV_{RMS}	< 800 mV_{PP} < 200 mV_{RMS}	< 2400 mV_{PP} < 400 mV_{RMS}
Remote sensing compensation	Max. 5% U_{Max}	Max. 5% U_{Max}	Max. 5% U_{Max}	Max. 5% U_{Max}	Max. 5% U_{Max}
Fall time at no load after switching DC output off	Down from 100% to <60 V: less than 10 s				
Current regulation					
Adjustment range	0...210 A	0...120 A	0...90 A	0...60 A	0...30 A
Accuracy (1 (at 23 ± 5°C)	< 0.2% I_{Max}	< 0.2% I_{Max}	< 0.2% I_{Max}	< 0.2% I_{Max}	< 0.2% I_{Max}
Line regulation at ±10% ΔU_{AC}	< 0.05% I_{Max}	< 0.05% I_{Max}	< 0.05% I_{Max}	< 0.05% I_{Max}	< 0.05% I_{Max}
Load regulation at 0...100% ΔU_{OUT}	< 0.15% I_{Max}	< 0.15% I_{Max}	< 0.15% I_{Max}	< 0.15% I_{Max}	< 0.15% I_{Max}
Ripple (2	< 66 mA_{RMS}	< 50 mA_{RMS}	< 48 mA_{RMS}	< 48 mA_{RMS}	< 26 mA_{RMS}
Display: Resolution	See section *"1.9.6.4. Resolution of the displayed values"*				
Display: Accuracy (4	≤ 0.2% I_{Max}	≤ 0.2% I_{Max}	≤ 0.2% I_{Max}	≤ 0.2% I_{Max}	≤ 0.2% I_{Max}
Power regulation					
Adjustment range	0…15.00 kW	0…15.00 kW	0…15.00 kW	0…15.00 kW	0…15.00 kW
Accuracy (1 (at 23 ± 5°C)	< 1% P_{Max}	< 1.2% P_{Max}	< 1.2% P_{Max}	< 1.2% P_{Max}	< 1.2% P_{Max}
Line regulation at ±10% ΔU_{AC}	< 0.05% P_{Max}	< 0.05% P_{Max}	< 0.05% P_{Max}	< 0.05% P_{Max}	< 0.05% P_{Max}
Load reg. at 10-90% ΔU_{OUT} * ΔI_{OUT}	< 0.75% P_{Max}	< 0.75% P_{Max}	< 0.75% P_{Max}	< 0.75% P_{Max}	< 0.75% P_{Max}

(1 Related to the nominal values, the accuracy defines the maximum deviation between an adjusted values and the true (actual) value.
Example: a 80 V model has min. 0.1% voltage accuracy, that is 80 mV. When adjusting the voltage to 5 V, the actual value is allowed to differ max. 80 mV, which means it might be between 4.92 V and 5.08 V.
(2 RMS value: LF 0...300 kHz, PP value: HF 0...20MHz
(3 Typical value at 100% output voltage and 100% power
(4 The display error adds to the error of the related actual value on the DC output.

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15 kW	Model 3U				
	PSI 9200-210	PSI 9360-120	PSI 9500-90	PSI 9750-60	PSI 91500-30
Power regulation					
Display: Resolution	See section *"1.9.6.4. Resolution of the displayed values"*				
Display: Accuracy (2	≤ 0.8% P_{Max}	≤ 0.85% P_{Max}	≤ 0.85% P_{Max}	≤ 0.85% P_{Max}	≤ 0.85% P_{Max}
Efficiency (6	~ 95%	~ 94%	~ 95%	~ 94%	~ 95%
Internal resistance regulation					
Adjustment range	0...28 Ω	0...90 Ω	0...166 Ω	0...375 Ω	0...1500 Ω
Accuracy (1	≤ 2% of max. resistance ± 0.3% of maximum current				
Display: Resolution	See section *"1.9.6.4. Resolution of the displayed values"*				
Display: Accuracy (2	≤ 0.4%	≤ 0.4%	≤ 0.4%	≤ 0.4%	≤ 0.4%
Analog interface (3					
Set value inputs	U, I, P	U, I, P	U, I, P	U, I, P	U, I, P
Actual value output	U, I	U, I	U, I	U, I	U, I
Control signals	DC on/off, Remote on/off	DC on/off, Remote on/off	DC on/off, Remote on/off	DC on/off, Remote on/off	DC on/off, Remote on/off
Status signals	CV, OVP, OT	CV, OVP, OT	CV, OVP, OT	CV, OVP, OT	CV, OVP, OT
Galvanic isolation to the device	Max. 1500 V DC	Max. 1500 V DC	Max. 1500 V DC	Max. 1500 V DC	Max. 1500 V DC
Insulation (4	Allowed float (potential shift) on the DC output:				
Negative terminal to PE	±400 V DC	±400 V DC	±725 V DC	±725 V DC	±1000V DC
Positive terminal to PE	+600 V DC	+600 V DC	+1000 V DC	+1000 V DC	+1500 V DC
Miscellaneous					
Cooling	Temperature controlled fans, front inlet, rear exhaust				
Ambient temperature	0..50°C				
Storage temperature	-20...70°C				
Humidity	< 80%, not condensing				
Standards	EN 61010, EN 61326 EMC TÜV approved acc. IEC 61000-6-2:2005 and IEC 61000-6-3:2006 Class B				
Overvoltage category	2				
Protection class	1				
Pollution degree	2				
Operational altitude	< 2000 m				
Digital interfaces					
Featured	1x USB-B for communication, 1x USB-A for functions, 1x GPIB (optional)				
Slot (standard version)	optional: CANopen, Profibus, Profinet, RS232, Devicenet, Ethernet, ModBus				
Galvanic isolation from device	Max. 1500 V DC				
Terminals					
Rear side	Share Bus, DC output, AC input, remote sensing, analog interface, USB-B, master-slave bus, AnyBus module slot				
Front side	USB-A				
Dimensions					
Enclosure (WxHxD)	19" x 3U x 609 mm				
Total (WxHxD)	483 x 133 x 714 mm				
Weight	~ 30 kg	~ 30 kg	~ 30 kg	~ 30 kg	~ 30 kg
Article number (400 V model) (5	06230365	06230366	06230367	06230368	06230369
Article number (208 V model) (5	upon request	upon request	upon request	06238368	upon request

(1 Related to the nominal values, the accuracy defines the maximum deviation between an adjusted values and the true (actual) value
(2 The display error adds to the error of the related actual value on the DC output
(3 For technical specifications of the analog interface see *"3.5.4.3 Analog interface specification" on page 52*
(4 All values valid for devices manufactured after 1st of July 2014
(5 Article number of the standard version, devices with options will have a different number
(6 Typical value at 100% output voltage and 100% power

1.8.4 Views

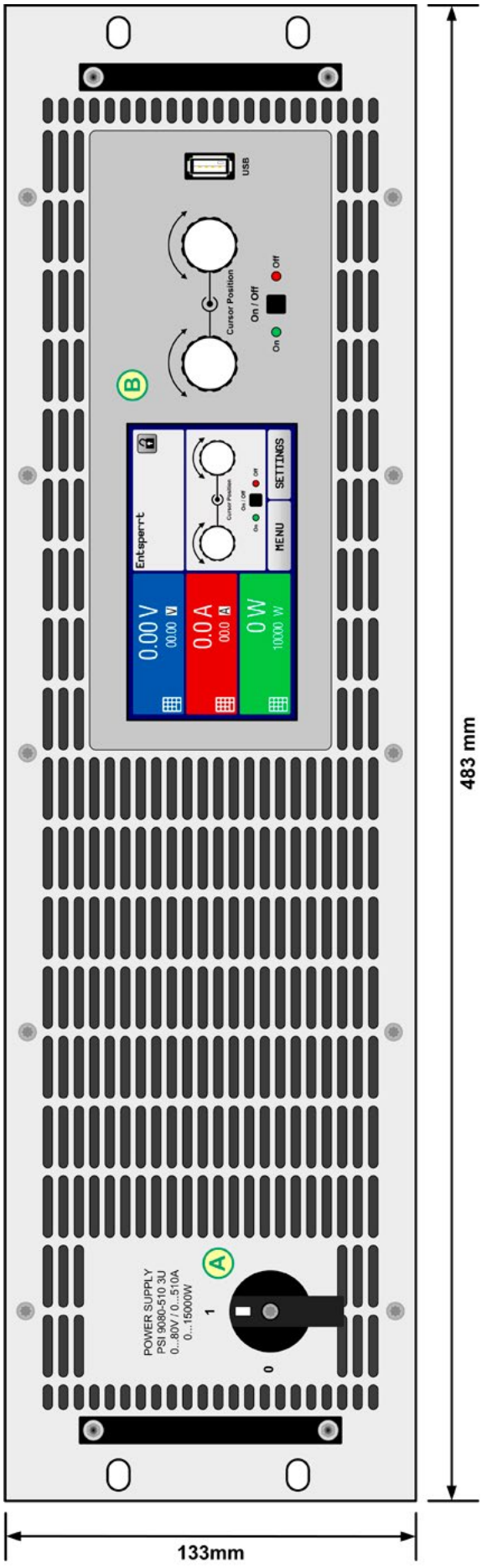

Figure 1 - Front side

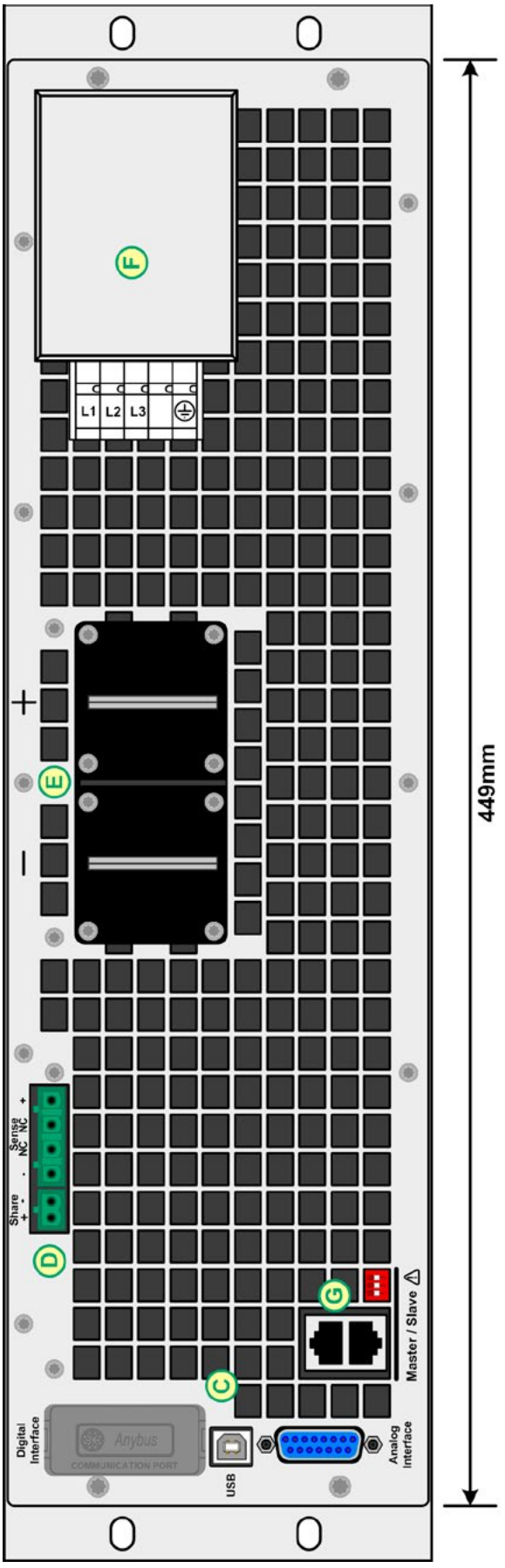

Figure 2 - Back side (standard version)

A - Mains switch
B - Control panel
C - Control interfaces (digital, analog)
D - Share Bus and remote sensing connection
E - DC output (view shows terminal type 1)
F - AC input connection
G - Master-Slave ports

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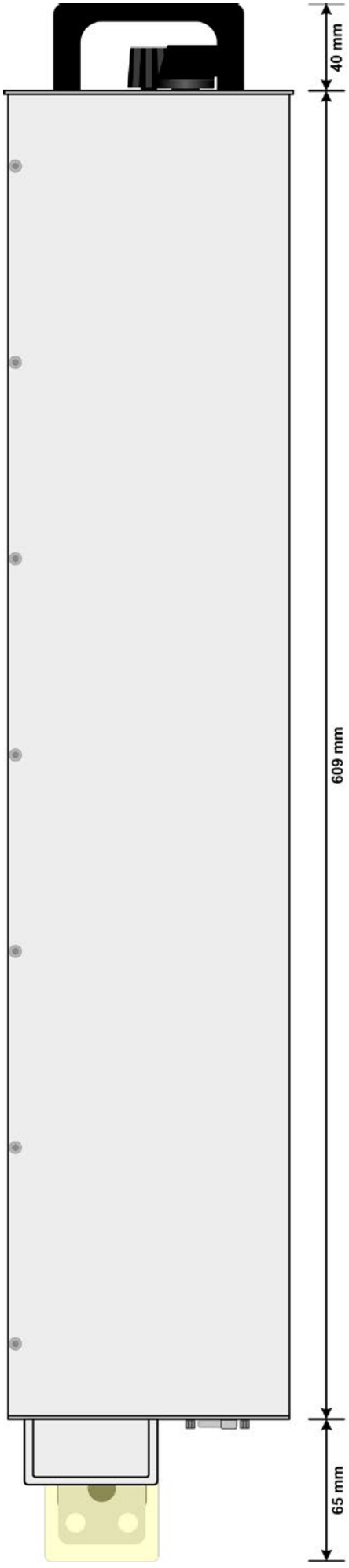

Figure 3 - Left hand side

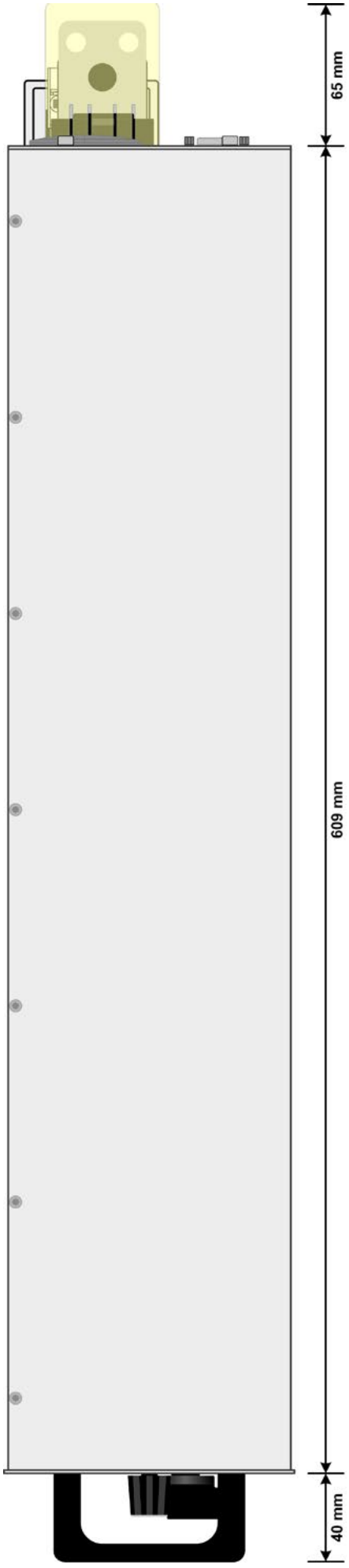

Figure 4 - Right hand side

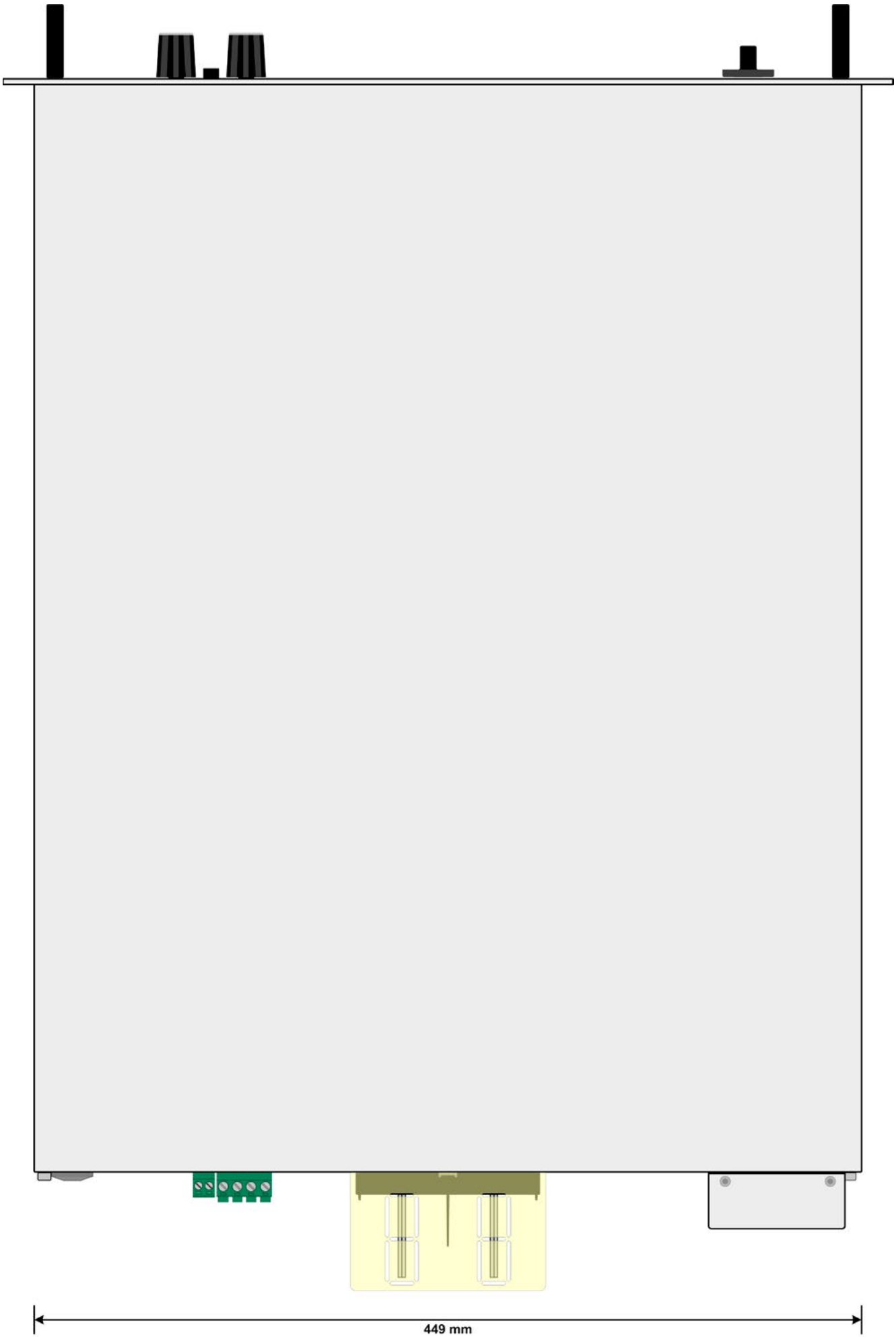

Figure 5 - View from above

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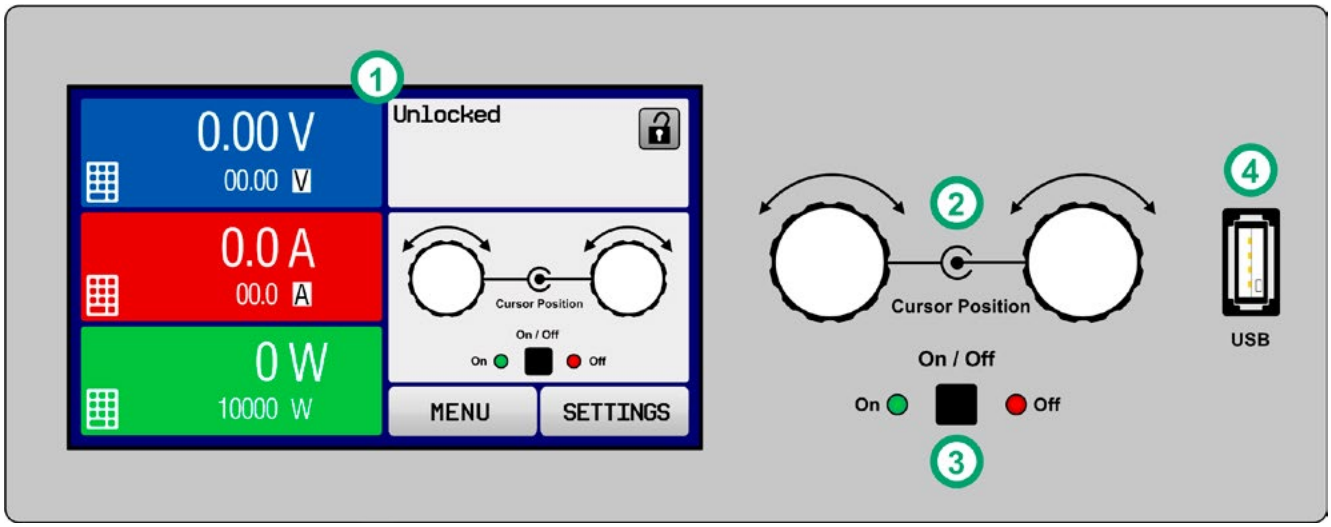


Figure 6 - Control Panel

Overview of the elements of the operating panel

For a detailed description see section *"1.9.6. The control panel (HMI)".*

(1)	**Touchscreen display** Used for selection of set values, menus, conditions and display of actual values and status. The touchscreen can be operated with the fingers or with a stylus.
(2)	**Rotary knob with push button function** Left knob (turn): adjusting the voltage set value, or setting the parameter values in the menu. Left knob (push): selection of the decimal position to be changed (cursor) in the current value selection. Right knob (turn): adjusting the current, power or resistance set value, or setting parameter values in the menu. Right knob (push): selection of the decimal position to be changed (cursor) in the current value selection.
(3)	**On/Off Button for DC output** Used to toggle the DC output between on and off, also used to start a function run. The LEDs "On" and "Off" indicate the state of the DC output, no matter if the device is manually controlled or remotely
(4)	**USB-A port** For the connection of standard USB sticks up to 32GB, formatted to FAT32. Value tables for the function generator (UI and IU functions) may be loaded or 100 arbitrary function sequences can be loaded or saved.

1.9 Construction and function

1.9.1 General description

The electronic high performance power supplies of the PSI 9000 3U series are especially suitable for test systems and industrial controls due to their compact construction in a 19” enclosure with 3 height units (3U). Apart from basic functions of power supplies, set point curves can be produced in the integrated function generator (sine, rectangular, triangular and other curve types). Arbitrary curves can be saved to and loaded from a USB flash drive.

For remote control using a PC or PLC the devices are provided as standard with a USB-B slot on the back side as well as a galvanically isolated analog interface.

Via optional plug-in interface modules, other digital interfaces such as Profibus, ProfiNet, ModBus, CANopen and more can be added. These enable the devices to be connected to standard industrial buses simply by changing or adding a small module. The configuration, if necessary at all, is simple. Thus the power supplies may, for example, be operated with other power supplies or even other types of equipment or controlled by a PC or PLC, all using the digital interfaces.

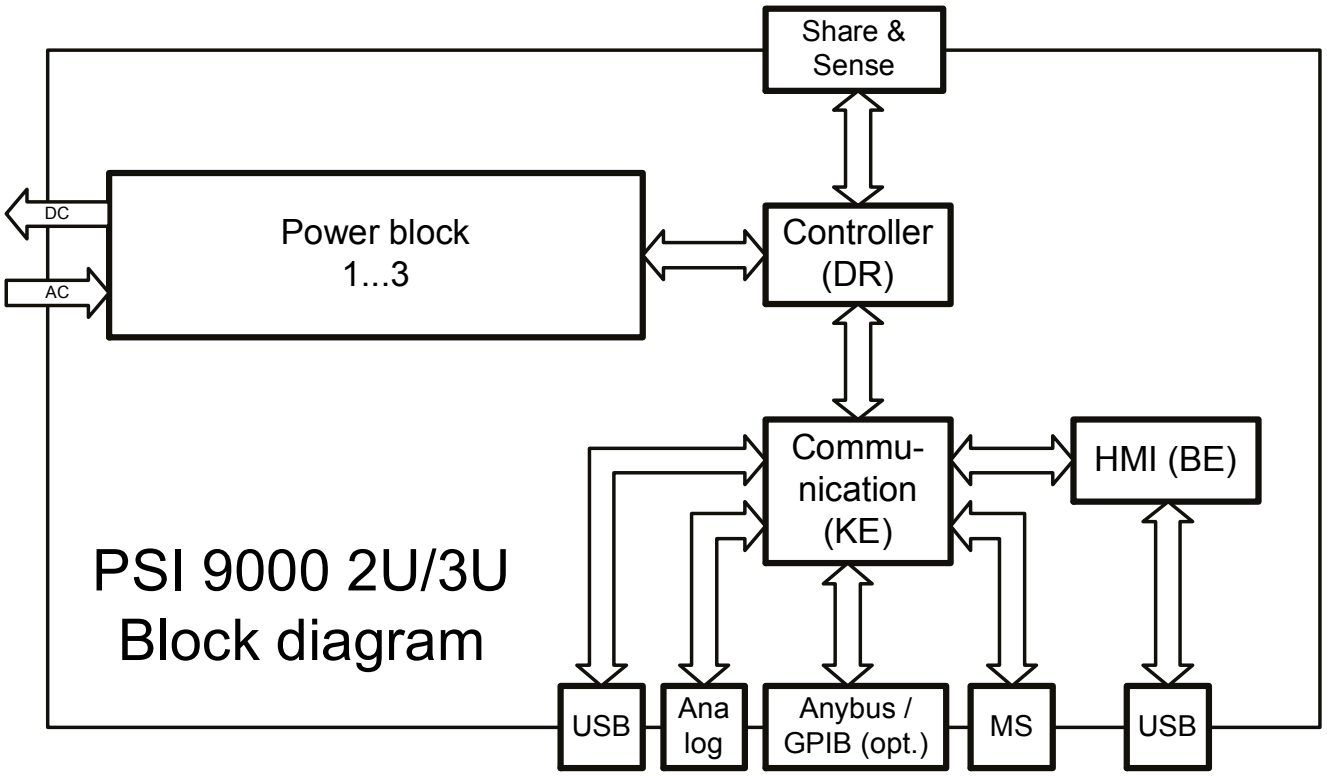
In addition, the devices offer as standard the possibility for parallel connection in Share bus operation for constant current sharing plus a genuine master-slave connection with totalizing of the slave units is also provided as standard. Operating in this way allows up to 10 units to be combined to a single system with a total power of up to 150 kW.

All models are contolled by microprocessors. These enable an exact and fast measurement and display of actual values.

1.9.2 Block diagram

The block diagram illustrates the main components inside the device and their relationships.

There are digital, microprocessor controlled components (KE, DR, BE), which can be target of firmware updates.



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1.9.3 Scope of delivery

1 x Power supply device

1 x Printed operating guide

1 x Share Bus plug

1 x Remote sensing plug

1 x 1.8 m USB cable

1 x Set of DC terminal covers

1 x CD “Drivers & Tools“

1 x AC connector plug (clamp type)

1 x Set for strain relief

1.9.4 Accessories

For these devices the following accessories are available:

Digital interface modules **IF-AB**	Pluggable and retrofittable AnyBus interface modules for RS232, CANopen, Ethernet, Profibus, ProfiNet, ModBus or Devicenet are available. Others upon request. Details about the interface modules and the programming of the device using those interfaces can be found in separate documentation. It is usually available on the CD, which is included with the device, or as PDF download on the manufacturers website.

1.9.5 Options

These options are usually ordered along with the device, as they are permanently built in or preconfigured during the manufacturing process. Retrofitting upon request.

CABINET 19”-rack	Racks in various configurations up to 42U as parallel systems are available, or mixed with electronic load devices to create test systems. Further information in our product catalogue, on our website or upon request
HS “High-Speed Ramping”	Increased output voltage dynamics through reduced output capacity. NOTE: other output values, as well as ripple also increase. This is a permanent feature which cannot be switched off.
3W GPIB interface	Replaces the standard slot for pluggable interface modules by a rigidly installed GPIB port. This option can be retrofitted upon request. The device will keep the USB and analog interfaces. Via the GPIB port, it can only support SCPI commands.

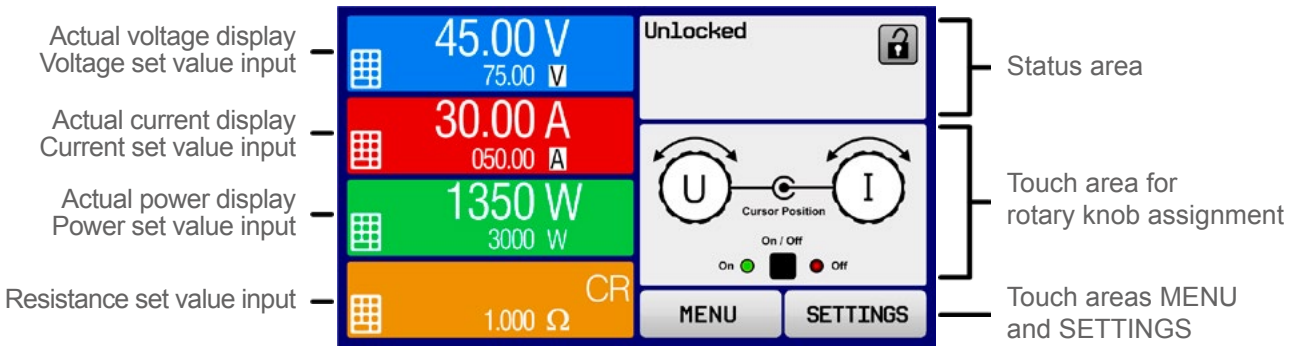
1.9.6 The control panel (HMI)

The HMI (**H**uman **M**achine **I**nterface) consists of a display with touchscreen, two rotary knobs, a pushbutton and a USB-A port.

1.9.6.1 Touchscreen display

The graphic touchscreen display is divided into a number of areas. The complete display is touch sensitive and can be operated by finger or stylus to control the equipment.

In normal operation the left hand side is used to show actual values and set values and the right hand side is used to display status information:



Touch areas may be enabled or disabled:

MENU Black text or symbol = Enabled SETTINGS Grey text or symbol = Disabled

This applies to all touch areas on the main screen and all menu pages..

- **Actual / set values area (left hand side)**

In normal operation the DC output values (large numbers) and set values (small numbers) for voltage, current and power are displayed. Resistance set value of the variable internal resistance is only displayed by active resistance mode.

When the DC output is switched on, the actual regulation mode, **CV, CC, CP** or **CR** is displayed next to the corresponding actual values, as show in the figure above.

The set values can be adjusted with the rotary knobs next to the display screen or can be entered directly via the touchscreen. When adjusting with the knobs, pushing the knob will select the digit to be changed. Logically, the values are increased by clockwise turning and decreased by anti-clockwise turning.

General display and setting ranges:

Display	Unit	Range	Description
Actual voltage	V	0-125% U_{Nom}	Actual values of DC output voltage
Set value voltage (1	V	0-102% U_{Nom}	Set value for limiting the DC output voltage
Actual current	A	0.1-125% I_{Nom}	Actual value of DC output current
Set value current (1	A	0-102% I_{Nom}	Set value for limiting the DC output current
Actual power	W	0-125% P_{Nom}	Actual value of output power, P = U * I
Set value power (1	W	0-102% P_{Nom}	Set value for limiting DC output power
Set value internal resistance(1	Ω	0-100% R_{Max}	Set value for the simulated internal resistance
Adjustment limits	A, V, kW	0-102% nom	U-max, I-min etc., related to the physical values
Protection settings	A, V, kW	0-110% nom	OVP, OCP etc., related to the physical values

(1 Valid also for values related to these physical units, such as OVD for voltage and UCD for current

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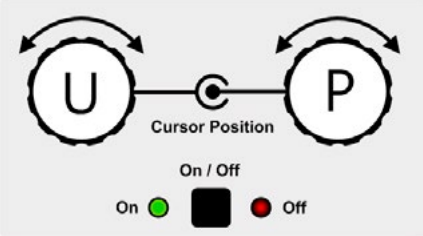
- **Status display (upper right)**

This area displays various status texts and symbols:

Display	Description
Locked	The HMI is locked
Unlocked	The HMI is unlocked
Remote:	The device is under remote control from....
Analog	....the built-in analog interface
USB & others	....the built-in USB port or a plug in interface module
Local	The device has been locked by the user explicitly against remote control
Alarm:	Alarm condition which has not been acknowledged or still exists.
Event:	A user defined event has occurred which is not yet acknowledged.
Master	Master-slave mode activated, device is master
Slave	Master-slave mode activated, device is slave
Function:	Function generator activated, function loaded
Stopped / Running	Status of the function generator resp. of the function

- **Area for assigning the rotary knobs**

The two rotary knobs next to the display screen can be assigned to various functions. This area shows the actual assignments. These can be changed by tapping this area, as long as it's not locked. The display changes to:



The physical units on the depiction of the knob shows the current assignment. With a power supply, the left knob is always assigned to the voltage U, while the right knob can be switched by tapping the depiction.

The area will then show the assignment:

U I	U P	U R
Left rotary knob: voltage Right rotary knob: current	Left rotary knob: voltage Right rotary knob: power	Left rotary knob: voltage Right rotary knob: resistance

The other set values can't be adjusted via the rotary knobs, unless the assignment is changed. However, values can be entered directly with a ten-key pad by tapping on the small icon . Alternatively to the knob depiction, the assignment can also be changed by tapping the coloured set value areas.

1.9.6.2 Rotary knobs

As long as the device is in manual operation, the two rotary knobs are used to adjust set values, as well as setting the parameters in the pages SETTINGS and MENU. For a detailed description of the individual functions see section *"3.4. Manual operation"*.

1.9.6.3 Pushbutton function of the knobs

The rotary knobs also have a pushbutton function which is used in all menu options for value adjustment to move the cursor by rotation as shown:

1.9.6.4 Resolution of the displayed values

In the display, set values can be adjusted in fixed increments. The number of decimal places depends on the device model. The values have 3 to 5 digits. Actual and set values always have the same number of digits.

Adjustment resolution and number of digits of set values in the display:

Voltage, OVP, UVD, OVD, U-min, U-max			Current, OCP, UCD, OCD, I-min, I-max			Power, OPP, OPD, P-max			Resistance, R-max		
Nominal	Digits	Min. Increment	Nominal	Digits	Min. Increment	Nominal	Digits	Min. Increment	Nominal	Digits	Min. Increment
40 V / 80 V	4	0.01 V	20 A / 30 A	4	0.01 A	3.3 kW	3	0.01 kW	2 Ω / 3,5 Ω	4	0.001 Ω
200 V	5	0.01 V	40 A / 60 A	4	0.01 A	5 kW	3	0.01 kW	5 Ω / 7 Ω	4	0.001 Ω
360 V / 500 V	4	0.1 V	70 A / 80 A	4	0.01 A	6.6 kW	3	0.01 kW	14 Ω / 28 Ω	5	0.001 Ω
750 V	4	0.1 V	90 A	4	0.01 A	10 kW	4	0.01 kW	42 Ω / 85 Ω	4	0.01 Ω
1000 V	5	0.1 V	120 A / 140 A	4	0.1 A	15 kW	4	0.01 kW	90 Ω	4	0.01 Ω
1500 V	5	0.1 V	170 A / 210 A	4	0.1 A				135 Ω / 166 Ω	5	0.01 Ω
			340 A	4	0.1 A				250 Ω / 270 Ω	5	0.01 Ω
			510 A	4	0.1 A				375 Ω / 500 Ω	4	0.1 Ω
									562 Ω	4	0.1 Ω
									1000 Ω / 1125 Ω	5	0.1 Ω
									1500 Ω	5	0.1 Ω

In manual operation every set value can be set in the increments given above. In this case the actual output values set by the device will lie within percentage tolerances as shown in the technical data sheets. These will influence the actual values.

1.9.6.5 USB port (front side)

The frontal USB port, located to the right of the rotary knobs, is intended for the connection of standard USB flash drives (flash drive). This can be used for:

- Loading or saving sequences for the arbitrary and loading tables for the UI-IU function generator
- Updating HMI firmware (new languages, functions)

USB flash drives must be **FAT32** formatted and have a **maximum capacity of 32GB**. All supported files must be held in a designated folder in the root path of the USB drive in order to be found. This folder must be named **HMI_FILES**, such that a PC would recognise the path G:\HMI_FILES if the drive were to be assigned the letter G. The control panel of the device can read the following file types from a flash drive:

*.bin (folder with two files)	Firmware updates only for the control panel. The file name format is given like 96230058_FW-BE1_V204.bin, listed in short form as FW-BE1_V204.bin. Other files won't be recognised or listed.
wave_u<arbitrary_text>.csv wave_i<arbitrary_text>.csv	Function generator for an arbitrary function on voltage (U) or current (I) The name must begin with *wave_u / wave_i*, the rest is user defined.
iu<arbitrary_text>.csv	IU table for the XY function generator. The name must begin with *iu*, the rest can be user defined.
ui<arbitrary_text>.csv	UI table for the XY function generator. The name must begin *with ui*, the rest can be user defined.
pv<arbitrary>.csv	PV (photovoltaics) table for XY the function generator. The name must begin with *pv*, the rest can be user defined.
fc<arbitrary>.csv	FC (fuel cell) table for the XY function generator. The name must begin with *fc*, the rest can be user defined.

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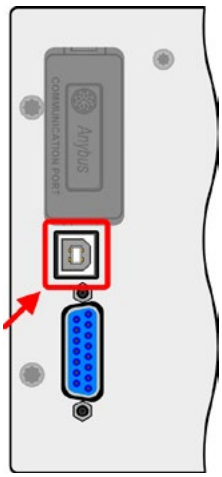
1.9.7 USB port type B (rear side)

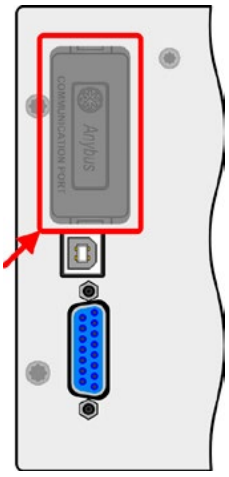


The USB-B port on the back side of the device is provided for communication with the device and for firmware updates. The included USB cable can be used to connect the device to a PC (USB 2.0 or 3.0). The driver is delivered on the included CD and installs a virtual COM port. Details for remote control can be found on the web site of the manufacturer or on the included CD. A general programming introduction for the USB port is available (date: 09-20-2015)

The device can be addressed via this port either using the international standard ModBus protocol or by SCPI language. The device recognises the message protocol used automatically.

If remote control is in operation the USB port has no priority over either the interface module (see below) or the analog interface and can, therefore, only be used alternatively to these. However, monitoring is always available.

1.9.8 Interface module slot



This slot on the back side of the device (only with standard models, units with option 3W installed are different) is available for various modules of the AnyBus CompactCom (abbr.: ABCC) type of the IF-AB interface series. The following options are available:

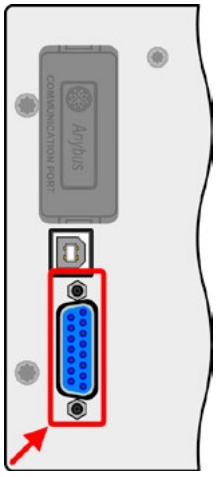
Article No.	Name	Description
35400100	IF-AB-CANO	CANopen, 1x Sub-D 9pole male
35400101	IF-AB-RS232	RS 232, 1x Sub-D 9pole male (null modem)
35400103	IF-AB-PBUS	Profibus DP-V1 Slave, 1x Sub-D 9pole female
35400104	IF-AB-ETH1P	Ethernet, 1x RJ45
35400105	IF-AB-PNET1P	ProfiNET IO, 1x RJ45
35400106	IF-AB-DNET	Devicenet, 1x Wago plug 5pole
35400107	IF-AB-MBUS1P	ModBus TCP, 1x RJ45
35400108	IF-AB-ETH2P	Ethernet, 2x RJ45
35400109	IF-AB-MBUS2P	ModBus TCP, 2x RJ45
35400110	IF-AB-PNET2P	ProfiNET IO, 2x RJ45

The modules are installed by the user and can be retrofitted without problem. A firmware update of the device may be necessary in order to recognize and support certain modules.

If remote control is in operation the interface module has no priority over either the USB port or the analog interface and can, therefore, only be used alternately to these. However, monitoring is always available.

Switch off device before adding or removing modules!

1.9.9 Analog interface

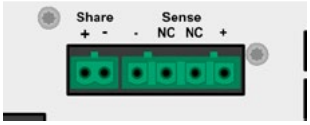


This 15 pole Sub-D socket on the back side of the device is provided for remote control of the device via analog signals or switching conditions.

If remote control is in operation this analog interface can only be used alternately to the digital interface. However, monitoring is always available.

The input voltage range of the set values and the output voltage range of the monitor values, as well as reference voltage level can be switched in the settings menu of the device between 0-5 V and 0-10 V, in each case for 0-100%.

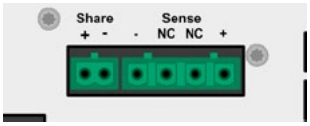
1.9.10 “Share” connector



The 2 pole WAGO socket (“Share”) on the back side of the device is provided for connection to equally named sockets on compatible power supplies series to achieve a balanced load current distribution during parallel connection. The socket is also used to connect the power supply to compatible electronic loads, in order to build a two-quadrants operation setup. Following power supply and electronic load series are compatible:

- PSI 9000 2U
- PSI 9000 3U
- ELR 9000

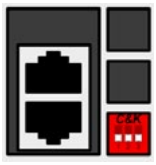
1.9.11 “Sense” connector (remote sensing)



In order to compensate for voltage drops along the DC cables to the load, the Sense input can be connected to the load. The maximum possible compensation is given in the technical specifications.

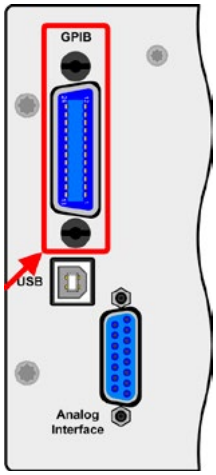
In order to ensure safety and to comply to international directives, insulation of high voltage models, i. e. such with a nominal voltage of 500 V or higher, is ensured by using only the two outer pins of the 4-pole terminal. The inner two pins, marked with NC, must remain unconnected.

1.9.12 Master-Slave bus



A further port is provided on the back side of the device, comprising two RJ45 sockets, which enables multiple identical devices to be connected via a digital bus (RS485) to create a master-slave system. Connection is made using standard CAT5 cables. These can theoretically have a length of up to 1200 m, but it is recommended to keep the connections as short as possible.

1.9.13 GPIB port (optional)



The optional GPIB connector, which is available with option 3W, will replace the Anybus slot of standard version devices. The device then offers a three-way interface with GPIB, USB and analog.

The connection to a PC or other GPIB port is done with standard GPIB cables from stock, which can have straight or 90° connectors.

When using cable with 90° connectors, the USB port will be inaccessible.

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2. Installation & commissioning

2.1 Transport and storage

2.1.1 Transport

- The handles on the front side of the device are **not** for carrying!
- Because of its weight, transport by hand should be avoided where possible. If unavoidable then only the housing should be held and not on the exterior parts (handles, DC output terminal, rotary knobs).
- Do not transport when switched on or connected!
- When relocating the equipment use of the original packing is recommended
- The device should always be carried and mounted horizontally
- Use suitable safety clothing, especially safety shoes, when carrying the equipment, as due to its weight a fall can have serious consequences.

2.1.2 Packaging

It is recommended to keep the complete transport packaging for the lifetime of the device for relocation or return to the manufacturer for repair. Otherwise the packaging should be disposed of in an environmentally friendly way.

2.1.3 Storage

In case of long term storage of the equipment it is recommended to use the original packaging or similar. Storage must be in dry rooms, if possible in sealed packaging, to avoid corrosion, especially internal, through humidity.

2.2 Unpacking and visual check

After every transport, with or without packaging, or before commissioning, the equipment should be visually inspected for damage and completeness using the delivery note and/or parts list (see section *"1.9.3. Scope of delivery"*). An obviously damaged device (e.g. loose parts inside, damage outside) must under no circumstances be put in operation.

2.3 Installation

2.3.1 Safety procedures before installation and use

- The device may, according to model, have a considerable weight. Therefore the proposed location of the equipment (table, cabinet, shelf, 19" rack) must be able to support the weight without restriction.
- When using a 19" rack, rails suitable for the width of the housing and the weight of the device are to be used. (see *"1.8.3. Specific technical data"*)
- Before connecting to the mains ensure that the connection is as shown on the product label. Overvoltage on the AC supply can cause equipment damage.

2.3.2 Preparation

Mains connection for the PSI 9000 3U series is done via the included 5 pole plug on the back of the device. Wiring of the plug is at least 3 strand (L1+L3+PE) or, for some models, 4 strand (L1+L2+L3+PE) of suitable cross section and length. For recommendations for cable cross section see *"2.3.4. Connection to AC supply"*.

Dimensioning of the DC wiring to the load/consumer has to reflect the following:

- The cable cross section should always be specified for at least the maximum current of the device.
- Continuous operation at the approved limit generates heat which must be removed, as well as voltage loss which depends on cable length and heating. To compensate for these the cable cross section should be increased and the cable length reduced.

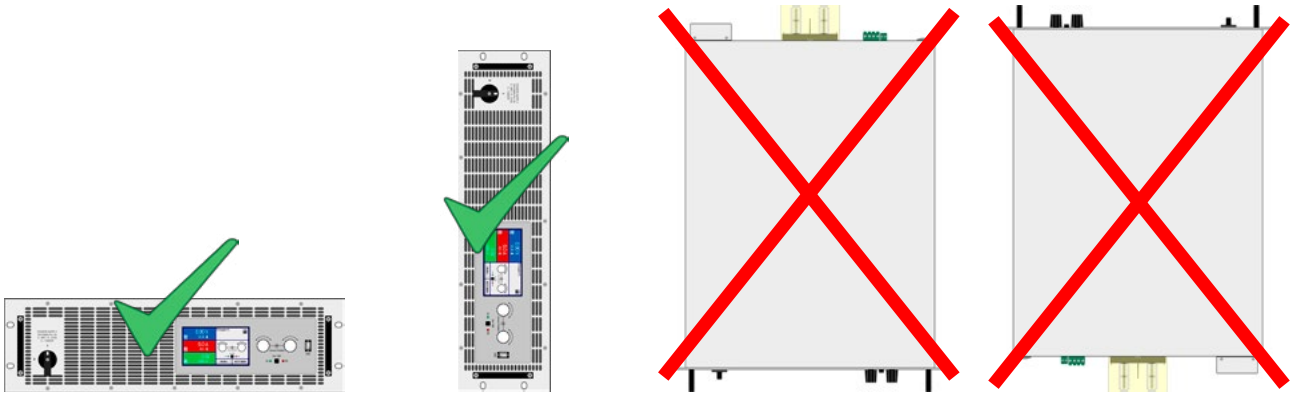
2.3.3 Installing the device

- Select the location for the device so that the connection to the load is as short as possible.
- Leave sufficient space behind the equipment, minimum 30cm, for ventilation.

A device in a 19" housing will usually be mounted on suitable rails and installed in 19" racks or cabinets. The depth of the device and its weight must be taken into account. The handles on the front are for sliding in and out of the cabinet. Slots on the front plate are provided for fixing the device (fixing screws not included).

On some models the mounting brackets provided to fix the device in a 19" cabinet can be removed so that the device can be operated on any flat surface as a desk top device.

Acceptable and inacceptable installation positions:



Standing surface

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2.3.4 Connection to AC supply

- Connection to an AC mains supply may only be carried out by qualified personnel!
- Cable cross section must be suitable for the maximum input current of the device (see tables below)!
- Before plugging in the input plug ensure that the device is switched off by its mains switch!

The device is delivered with a 5 pole (400 V models) or 4 pole (208 V models) mains plug. Depending on model, it will be connected with 2 or 3 phases of a three-phase supply according to the description on the plug and the table below. Required for the mains connection are following phases:

Nominal power	Phases	Supply type
3.3 kW / 5 kW	L2, L3, PE	Three-phase
6.6 kW / 10 kW	L1, L2, L3, PE	Three-phase
15 kW	L1, L2, L3, PE	Three-phase
>15 kW	L1, L2, L3, PE	Three-phase

For the required wiring **cross section,** the power of the device and the cable length are decisive. The tables below give the maximum input current for each phase as well the recommended cross section for cable lengths up to 5m.

2.3.4.1 Models for 400 V AC supply (Europe, US)

Maximum AC input currents and minimum wire cross section based on the connection of a **standalone unit**:

	L1		L2		L3	
Nominal power	ø	I_{max}	ø	I_{max}	ø	I_{max}
3.3 kW	-	-	2,5 mm²	11 A	2,5 mm²	11 A
5 kW	-	-	2,5 mm²	16 A	2,5 mm²	16 A
6.6 kW	2,5 mm²	19 A	2,5 mm²	11 A	2,5 mm²	11 A
10 kW	4 mm²	28 A	4 mm²	16 A	4 mm²	16 A
10 kW (40 V U_{out})	2,5 mm²	19 A	2,5 mm²	19 A	2,5 mm²	19 A
15 kW	4 mm²	28 A	4 mm²	28 A	4 mm²	28 A

2.3.4.2 Models for 208 V AC supply (US)

Maximum AC input currents and minimum cross section[1] based on the connection of a **standalone unit**:

	L1		L2		L3	
Nominal power	ø	I_{max}	ø	I_{max}	ø	I_{max}
3.3 kW	-	-	AWG 12	21 A	AWG 12	21 A
5 kW	-	-	AWG 10	31 A	AWG 10	31 A
6.6 kW	AWG 8	37 A	AWG 8	21 A	AWG 8	21 A
10 kW	AWG 6	54 A	AWG 6	31 A	AWG 6	31 A
10 kW (40 V U_{Nom})	AWG 8	37 A	AWG 8	37 A	AWG 8	37 A
15 kW	AWG 6	54 A	AWG 6	54 A	AWG 6	54 A

The included connection plug can receive conductor ends of up to 4 mm² / AWG 10 (400 V models) or up to 16 mm² /AWG 6 (208 V models). The longer the connection cable, the higher the voltage loss due to the cable resistance. Therefore the mains cables should be kept as short as possible.

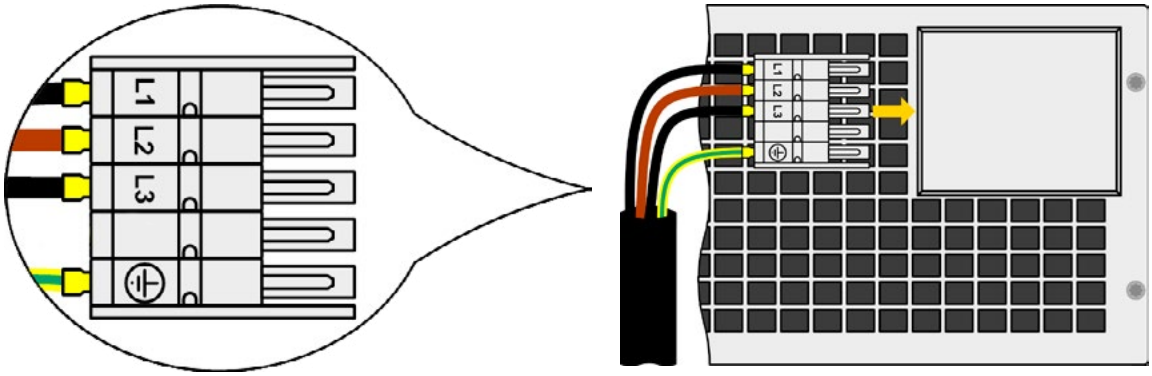


Figure 7 - Example for a mains cable for 400 V models (cable not included in delivery)

1 Derived from NFPA 79, for conductors rated up to 60°C/140°F, up to 3 cores

2.3.5 Connection to DC loads

- In the case of a device with a high nominal current and hence a thick and heavy DC connection cable it is necessary to take account of the weight of the cable and the strain imposed on the DC connection. Especially when mounted in a 19” cabinet or similar, where the cable hangs on the DC output, a strain reliever should be used.
- Connection to and operation with transformerless DC-AC inverters (for example solar inverters) is restricted, because the inverter can shift the potential of negative output (DC-) against PE (ground), which is generally limited to max. 400 V DC.

The DC load output is on the back side of the device and is **not** protected by a fuse. The cross section of the connection cable is determined by the current consumption, cable length and ambient temperature.

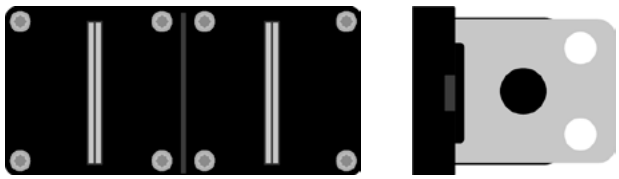
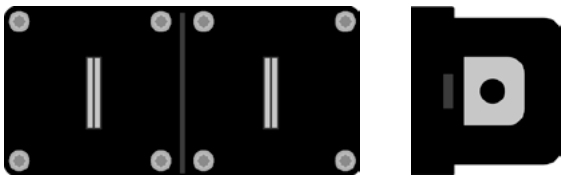
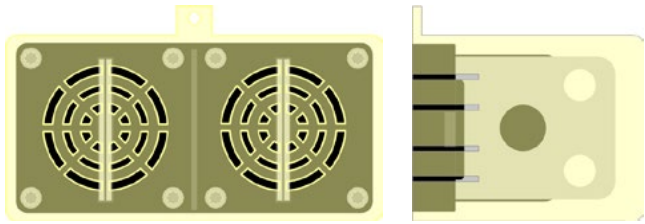
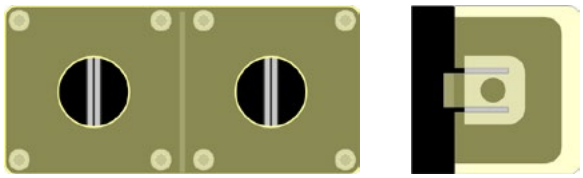
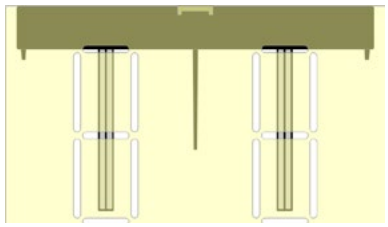
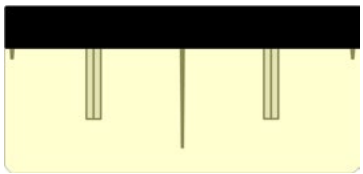
For cables up to 1.5 m and average ambient temperature up to 50°C, we recommend:

up to **30 A**:	6 mm²	up to **70 A**:	16 mm²
up to **90 A**:	25 mm²	up to **140 A**:	50 mm²
up to **170 A**:	70 mm²	up to **210 A**:	95 mm²
up to **340 A**:	2x70 mm²	up to **510 A**:	2x120 mm²

per connection pole (multi-conductor, insulated, openly suspended). Single cables of, for example, 70 mm² may be replaced by e.g. 2x35 mm² etc. If the cables are long then the cross section must be increased to avoid voltage loss and overheating.

2.3.5.1 DC terminal types

The table below shows an overview of the various DC terminals. It is recommended that connection of load cables always utilises flexible cables with ring lugs.

Type 1: Models up to 360 V output voltage	Type 2: Models from 500 V output voltage
	
M8 bolt on a metal rail Recommendation: ring lug with a 8 mm hole	M6 bolt on a metal rail Recommendation: ring lug with a 6 mm hole
	
	

2.3.5.2 Cable lead and plastic cover

A plastic cover for contact protection is included for the DC terminal. It should always be installed. The cover for type 2 (see picture above) is fixed to the connector itself, for type 1 to the back of the device. Furthermore the cover for type 1 has break outs so that the supply cable can be laid in various directions.

The connection angle and the required bending radius for the DC cable must be taken into account when planning the depth of the complete device, especially when installing in a 19” cabinet or similar. For type 2 connectors only a horizontal lead can be used to allow for installation of the cover.

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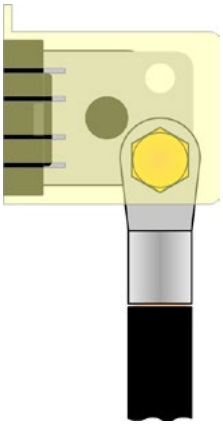
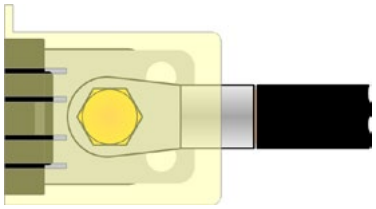
Examples of the type 1 terminal:



- 90° up or down
- space saving in depth
- no bending radius



- horizontal lead
- space saving in height
- large bending radius

2.3.6 Grounding of the DC output

No matter if the power supply is operated stand-alone or in series connection with others, it is always only allowed to ground one of all DC output poles. Following also has to be considered:

Because of isolation, there is a max. allowed potential shift of the DC output poles, which also depends on the device model. Refer to *"1.8.3. Specific technical data"* for details.

The DC minus pole of a stand-alone unit can be grounded right away, but it should only be done if absolutely necessary, because the DC output is connected to PE via X capacitors in order to gain a better HF filtering.

- Digital and analog interface are galvanically isolated from the DC output and should never be grounded, but under no circumstances if any of the DC output poles is grounded too, because this will cancel the galvanic isolation
- If grounding one of the DC output poles check if any pole of the load is already grounded. This could lead to a short circuit!

2.3.7 Connecting the "Share" bus

The "Share" bus connector on the back side is intended to balance the current of multiple units in parallel operation, especially when using the integrated function generator of the master unit. Alternatively, it can be connected to a compatible electronic load, like from series ELR 9000, in order to run a two-quadrants operation. For further information about this mode of operation can be found in section *"3.10.4. Two quadrants operation (2QO)"*.

For the connection of the share bus the following must be paid attention to:

- Connection is only permitted between compatible devices (see *"1.9.10. "Share" connector"* for details) and between a max. of 10 units
- If a two-quadrants operation system has to be set up where multiple power supplies are connected to one electronic load unit or a group of electronic loads, all units should be connected via Share bus. One power supply unit is then configured as Share bus master, similar to true master-slave operation. The group of power supplies may use the master-slave bus for true master-slave operation, the group of loads may not, because there must be only one master unit on the Share bus.

2.3.8 Connection of remote sense

Both pins "NC" of the Sense connector must not be wired!

- The cross section of the sense cables is noncritical. Recommendation for cables up to 5 m: use at least 0.5 mm²
- Sense cables should be twisted and laid close to the DC cables to damp oscillation. If necessary, an additional capacitor should be installed at the load/consumer to eliminate oscillation
- The + sense cables must be connected to + on the load and - sense to - at the load, otherwise the sense input of the power supply can be damaged. For an example see *Figure 8* below.
- In master-slave operation, the remote sensing should be connected to the master unit only

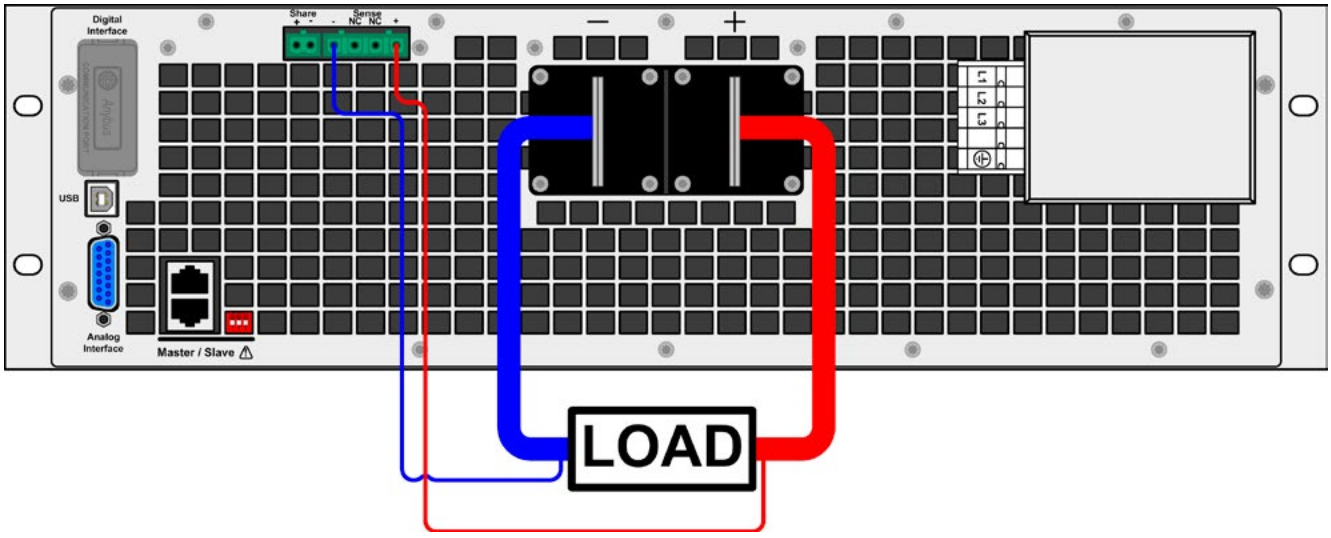


Figure 8 - Example for remote sensing wiring

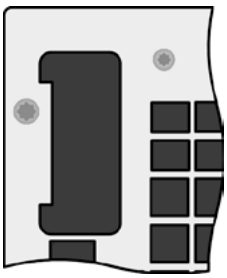
2.3.9 Installation of an AnyBus interface module

The various interface modules, which are available for PSI 9000 3U standard version models with Anybus slot, can be retrofitted by the user and are exchangeable with each other. The settings for the currently installed module vary and need to be checked and, if necessary, corrected on initial installation and after module exchange.

- Common ESD protection procedures apply when inserting or exchanging a module.
- The device must be switched off before insertion or removal of a module
- Never insert any other hardware other than an AnyBus-CompactCom module into the slot
- If no module is in use it is recommended that the slot cover is mounted in order to avoid internal dirtying of the device and changes in the air flow.

Installation steps:

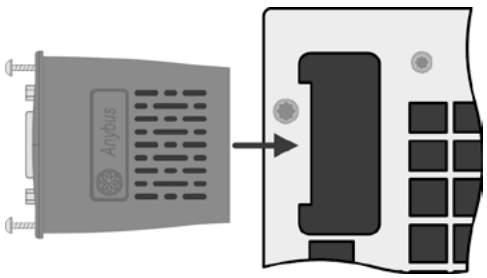
1.



Remove the slot cover. If needed use a screw driver.

Check that the fixing screws of an already installed module are fully retracted. If not, unscrew them (Torx 8) and remove module.

2.

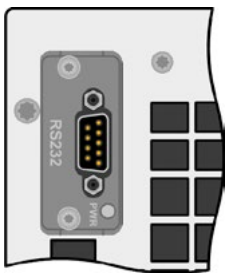


Insert the interface module into the slot. The shape ensures correct alignment.

When inserting take care that it is held as close as possible to a 90° angle to the rear wall of the device. Use the green PCB, which you can recognize on the open slot as, as guide. At the end is a socket for the module.

On the underside of the module are two plastic nibs which must click into the green PCB so that the module is properly aligned on the rear wall of the device.

3.



Slide the module into place as far as it will go.

The screws (Torx 8) are provided for fixing the module and should be fully screwed in. After installation, tre module is ready for use and can be connected.

Removal follows the reverse procedure. The screws can be used to assist in pulling out the module.

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2.3.10 Connecting the analog interface

The 15 pole connector (Type: Sub-D, D-Sub) on the rear side is an analog interface. To connect this to a controlling hardware (PC, electronic circuit), a standard plug is necessary (not included in the scope of delivery). It is generally advisable to switch the device completely off before connecting or disconnecting this connector, but at least the DC output.

The analog interface is galvanically isolated from the device internally. Therefore do not connect any ground of the analog interface (AGND) to the DC minus output as this will cancel the galvanic isolation.

2.3.11 Connecting the USB port (rear side)

In order to remotely control the device via this port, connect the device with a PC using the included USB cable and switch the device on.

2.3.11.1 Driver installation (Windows)

On the initial connection with a PC the operating system will identify the device as new hardware and will install the driver. The driver is a Communications Device Class (CDC) type and is usually integrated in current operating systems such as Windows 7 or XP and is therefore not provided additionally. There are, however, versions such as Windows 7 Embedded in which the class of driver is not installed or does not function.

On the included CD is a driver information file (*.inf) which can install the device as a virtual COM port (VCOM).

Following recognition, the USB equipment will first be listed in the Windows Device Manager as “other hardware” (Windows 7) and the driver may possibly not be fully installed. In this case take the following steps:

In Device Manager click with right mouse button on the not fully installed hardware. Select “Update driver”

1. Windows will ask if the driver should be automatically searched or whether it should be located and installed manually. Select the latter (second choice in the dialogue window).
2. In the next dialogue window the driver source path will be determined. Click on “Search” and enter the folder of the USB driver from the “Drivers & Tools” CD or the path to the downloaded and unpacked driver. Allow Windows to install the driver. A message that the driver is not digitally signed can be submitted with “Ignore”.

2.3.11.2 Driver installation (Linux, MacOS)

We cannot provide drivers or installation instructions for these operating systems. Whether a suitable driver is available is best carried out by searching the Internet.

2.3.11.3 Alternative drivers

In case the CDC drivers described above are not available on your system, or for some reason do not function correctly, commercial suppliers can help. Search the Internet for suppliers using the keywords “cdc driver windows” or “cdc driver linux” or “cdc driver macos”.

2.3.12 Initial commission

For the first start-up after installation of the device, the following procedures have to be executed:

- Confirm that the connection cables to be used are of a satisfactory cross section!
- Check if the factory settings of set values, safety and monitoring functions and communication are suitable for your intended application of the device and adjust them if required, as described in the manual!
- In case of remote control via PC, read the additional documentation for interfaces and software!
- In case of remote control via the analog interface, read the section in this manual concerning analog interfaces!

2.3.13 Commission after a firmware update or a long period of non-use

In case of a firmware update, return of the equipment following repair or a location or configuration change, similar measures should be taken to those of initial start up. Refer to *“2.3.12. Initial commission”.*

Only after successful checking of the device as listed may it be operated as usual.

3. Operation and application

3.1 Personal safety

- In order to guarantee safety when using the device, it is essential that only persons operate the device who are fully acquainted and trained in the required safety measures to be taken when working with dangerous electrical voltages
- For models which can generate a voltage which is dangerous by contact, or is connected to such, the included DC terminal cover, or an equivalent, must always be used
- Whenever the load and DC output are being re-configured, the device should be disconnected from the mains, not only the DC output switched off!

3.2 Operating modes

A power supply is internally controlled by different control or regulation circuits, which shall bring voltage, current and power to the adjusted values and hold them constant, if possible. These circuits follow typical laws of control systems engineering, resulting in different operating modes. Every operating mode has its own characteristics which is explained below in short form.

- *Unloaded operation is not considered as a normal operation mode and can thus lead to false measurements, for example when calibrating the device*
- *The optimal working point of the device is between 50% and 100% voltage and current*
- *It is recommended to not run the device below 10% voltage and current, in order to make sure technical values like ripple and transient times can be met*

3.2.1 Voltage regulation / Constant voltage

Voltage regulation is also called constant voltage operation (CV).

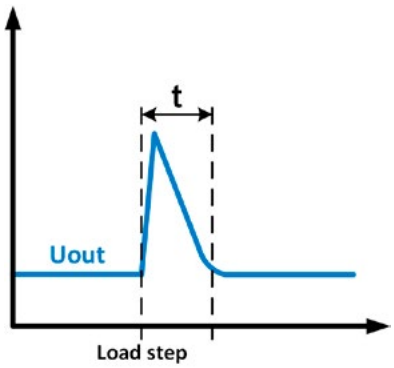
The DC output voltage of a power supply is held constant on the adjusted value, unless the output current or the output power according to $P = U_{OUT} * I_{OUT}$ reaches the adjusted current or power limit. In both cases the device will automatically change to constant current or constant power operation, whatever occurs first. Then the output voltage can't be held constant anymore and will sink to a value resulting from Ohm's law.

While the DC output is switched on and constant voltage mode is active, then the condition "CV mode active" will be indicated on the graphic display by the abbreviation CV and this message will be passed as a signal to the analog interface, as well stored as status which can also be read as a status message via digital interface.

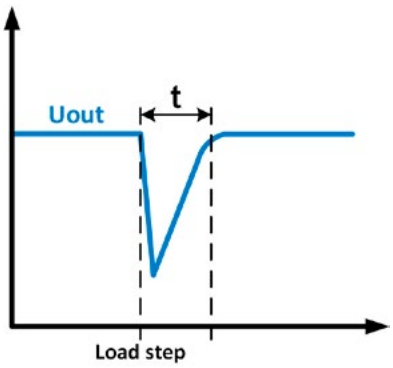
3.2.1.1 Transient time after load step

For constant voltage mode (CV), the technical date "Transient time after load step" (see *1.8.3*) defines a time that is required by the internal voltage regulator of the device to settle the output voltage after a load step. Negative load steps, i.e. high load to lower load, will cause the output voltage to overshoot for a short time until compensated by the voltage regulator. The same occurs with a positive load step, i.e. low load to high load. There the output collapses for a moment. The amplitude of the overshoot resp. collapse depends on the device model, the currently adjusted output voltage and the capacity on the DC output and can thus not be stated with a specific value.

Depictions:



Example for neg. load step: the DC output will rise above the adjusted value for a short time. t = transient time to settle the output voltage.



Example for pos. load step: the DC output will collapse below the adjusted value for a short time. t = transient time to settle the output voltage.

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3.2.2 Current regulation / constant current / current limiting

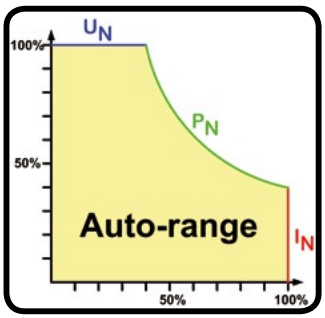
Current regulation is also known as current limiting or constant current mode (CC).

The DC output current is held constant by the power supply, once the output current to the load reaches the adjusted limit. Then the power supply automatically switches The current flowing from the power supply is determined by the output voltage and the load's true resistance. As long as the output current is lower than the adjusted current limit, the device will be either in constant voltage or constant power mode. If, however, the power consumption reaches the set maximum power value, the device will switch automatically to power limiting and sets the output current according to $I_{MAX} = P_{SET} / U_{IN}$, even if the maximum current value is higher. The current set value, as determined by the user, is always an upper limit only.

While the DC output is switched on and constant current mode is active, then the condition "CC mode active" will be indicated on the graphic display by the abbreviation CC and this message will be passed as a signal to the analog interface, as well stored as status which can also be read as a status message via digital interface.

3.2.3 Power regulation / constant power / power limiting

Power regulation, also known as power limiting or constant power (CP), keeps the DC output power of a power supply constant if the current flowing to the load in relation to the output voltage and the resistance of load reaches the adjusted value according to P = U * I resp. P = U² / R. The power limiting then regulates the output current according to I = sqr(P / R), where R is the load's resistance.



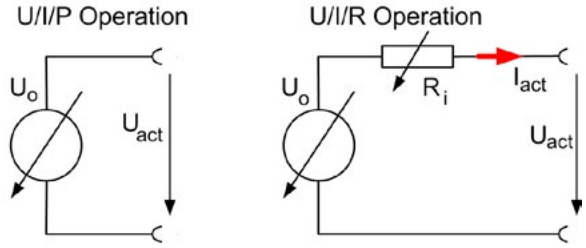
Power limiting operates according to the auto-range principle such that at lower output voltages higher current flows and vice versa in order to maintain constant power within the range P_N (see diagram to the right).

While the DC output is switched on and constant power mode is active, then the condition "CP mode active" will be shown on the graphic display by the abbreviation CP, as well stored as status which can also be read as a status message via digital interface.

3.2.4 Internal resistance regulation

Internal resistance control (abbr. CR) of power supplies is the simulation of a virtual internal resistor which is in series to the voltage source and thus also in series to the load. According to Ohm's law, this causes a voltage drop, which will result in a difference between adjusted output voltage and actual output voltage. This will work in constant current mode as well as in constant power mode, but here the output voltage will differ even more from the adjusted voltage, because then constant voltage is not active.

The adjustable resistance range is generally defined between 0 and 30 * U_{NOM} / I_{NOM} of the particular model. The voltage setting in dependency of the resistance set value and the output current is done by calculation of the microcontroller and thus will be significantly slower the other controllers inside the control circuit. Clarification:



$$U_{Set} = U_0 - I_{Act} * R_{Set} \Big|^{P_{Set},\, I_{Set}}$$

With resistance mode being active, i.e. mode R/I, the function generator will be offline.

3.3 Alarm conditions

This section only gives an overview about device alarms. What to do in case your device indicates an alarm condition is described in section "3.6. Alarms and monitoring".

As a basic principle, all alarm conditions are signalled optically (text + message in the display), acoustically (if activated) and as a readable status and alarm counter via the digital interface. In addition, the alarms OT and OVP are reported as signals on the analogue interface. For later acquisition, an alarm counter can be read from the display or via digital interface.

3.3.1 Power Fail

Power Fail (PF) indicates an alarm condition which may have various causes:

- AC input voltage too low (mains undervoltage, mains failure)
- Defect in the input circuit (PFC)
- Not all required AC input phases are connected (see *"2.3.4. Connection to AC supply"* for requirements)

As soon as a power fail occurs, the device will stop to supply power and switch off the DC output. In case the power fail was an undervoltage and is gone later on, the alarm will vanish from display and doesn't require to be acknowledged.

Switching off the device by the mains switch can't be distinguished from a mains blackout and thus the device will signalise a PF alarm every time the device is switched off. This can be ignored.

The condition of the DC output after a PF alarm during normal operation can be set up. See "3.4.3. Configuration via MENU".

3.3.2 Overtemperature

An overtemperature alarm (OT) can occur if an excess temperature inside the device and causes it to stop supplying power temporarily. After cooling down, the device will automatically continue to supply power, while the condition of the DC output remains and the alarm doesn't require to be acknowledged.

3.3.3 Overvoltage protection

An overvoltage alarm (OVP) will switch off the DC output and can occur if:

- the power supply itself, as a voltage source, generates an output voltage higher than set for the overvoltage alarm limit (OVP, 0...110% U_{Nom}) or the connected load somehow returns voltage higher than set for the overvoltage alarm limit
- the OV threshold has been adjusted too close above the output voltage. If the device is in CC mode and if it then experiences a negative load step, it will make the voltage rise quickly, resulting in an voltage overshoot for a short moment which can already trigger the OVP

This function serves to warn the user of the power supply acoustically or optically that the device probably has generated an excessive voltage which could damage the connected load application.

- The device is not fitted with protection from external overvoltage
- The changeover from operation modes CC -> CV can generate voltage overshoots

3.3.4 Overcurrent protection

An overcurrent alarm (OCP) will switch off the DC output and can occur if:

- The output current in the DC output reaches the adjusted OCP limit.

This function serves to protect the connected load application so that this is not overloaded and possibly damaged due to an excessive current.

3.3.5 Overpower protection

An overpower alarm (OPP) will switch off the DC output and can occur if:

- the product of the output voltage and output current in the DC output reaches the adjusted OPP limit.

This function serves to protect the connected load application so that this is not overloaded and possibly damaged due to an excessive power consumption.

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3.4 Manual operation

3.4.1 Switching on the device

The device should, as far as possible, always be switched on using the rotary switch on the front of the device. Alternatively this can take place using an external cutout (contactor, circuit breaker) of suitable current capacity.

After switching on, the display will first show the manufacturers logo (approx. 10 s) followed by the manufacturers name, address, device model, firmware version(s), serial number and item number (approx. 3 s). In setup (see section *"3.4.3. Configuration via MENU"* in the second level menu "**General settings**" is an option "**Output after power ON**" in which the user can determine the condition of the DC output after power-up. Factory setting here is "**OFF**", meaning that the DC output on power-up is always switched off. "**Restore**" means that the last condition of the DC output will be restored, either on or off. All set values are always saved and restored.

3.4.2 Switching off the device

On switch-off the last output condition and the most recent set values are saved. Furthermore, a PF alarm (power failure) will be reported, but can be ignored.

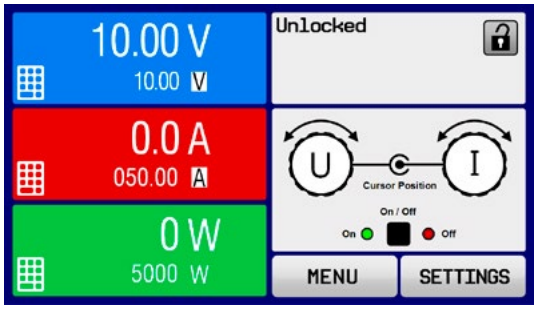
The DC output is immediately switched off and after a short while fans will shut down and after another few seconds the device will be completely powered off.

3.4.3 Configuration via MENU

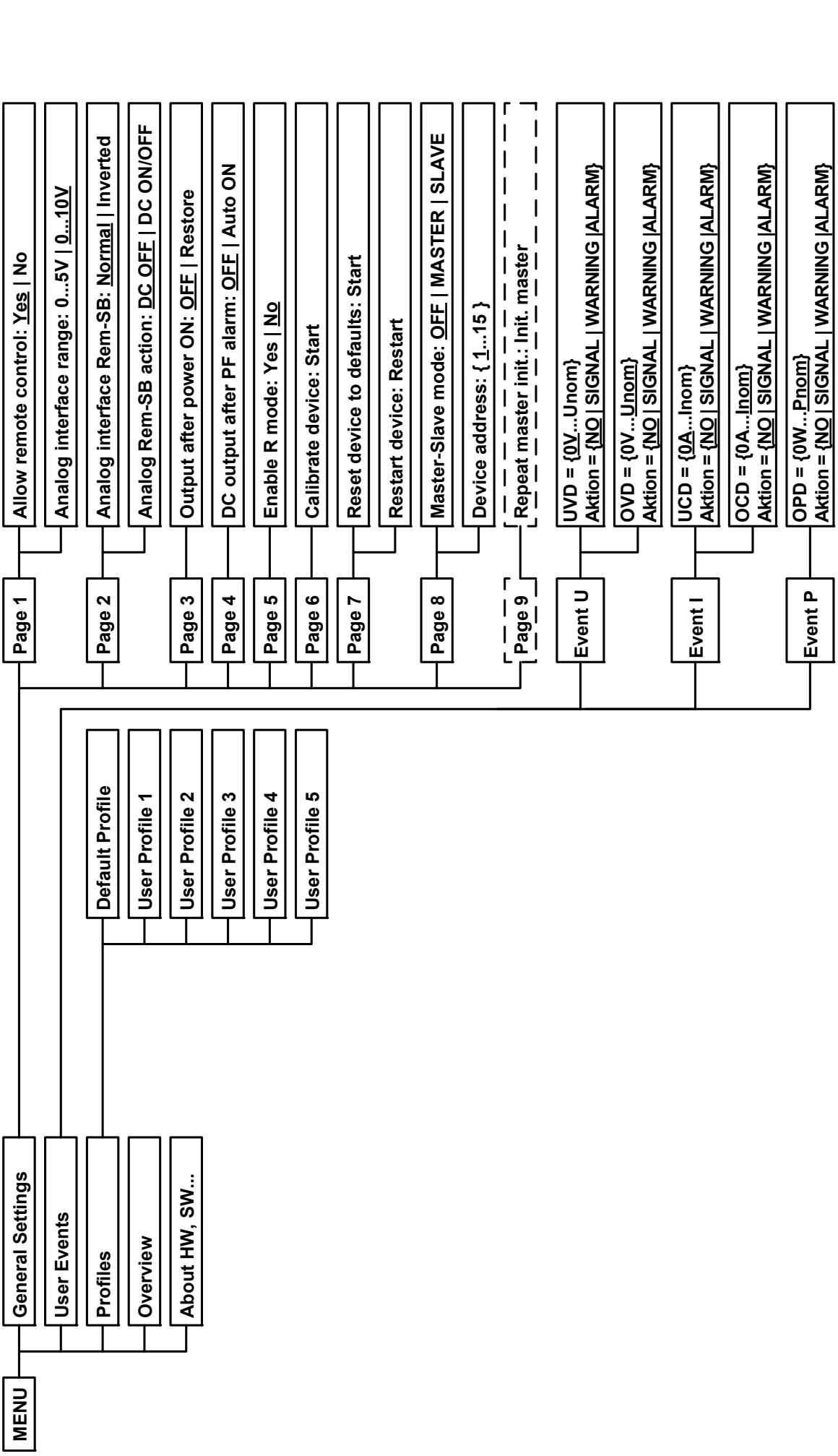
The MENU serves to configure all operating parameters which are not constantly required. These can be set by finger touch on the MENU touch area, but only if the DC output is switched OFF. See figure to the right.

If the DC output is switched on the settings menu will not be shown, only status information.

Menu navigation is by finger touch. Values are set using the rotary knobs. The assignments of the rotary knobs, if multiple values can be set in a particular menu, are shown on the menu pages in the lower middle.



The menu structure is shown schematically on the following pages. Some setting parameters are self-explanatory, others are not. The latter will be explained on the pages following.


MENU
General Settings
User Events
Profiles
Overview
About HW, SW...
Default Profile
User Profile 1
User Profile 2
User Profile 3
User Profile 4
User Profile 5
Page 1
Allow remote control: Yes | No
Analog interface range: 0...5V | 0...10V
Page 2
Analog interface Rem-SB: Normal | Inverted
Analog Rem-SB action: DC OFF | DC ON/OFF
Page 3
Output after power ON: OFF | Restore
Page 4
DC output after PF alarm: OFF | Auto ON
Page 5
Enable R mode: Yes | No
Page 6
Calibrate device: Start
Page 7
Reset device to defaults: Start
Restart device: Restart
Page 8
Master-Slave mode: OFF | MASTER | SLAVE
Device address: { 1...15 }
Page 9
Repeat master init.: Init. master
Event U
UVD = {0V...Unom}
Aktion = {NO | SIGNAL | WARNING |ALARM}
OVD = {0V...Unom}
Aktion = {NO | SIGNAL | WARNING |ALARM}
Event I
UCD = {0A...Inom}
Aktion = {NO | SIGNAL | WARNING |ALARM}
OCD = {0A...Inom}
Aktion = {NO | SIGNAL | WARNING |ALARM}
Event P
OPD = {0W...Pnom}
Aktion = {NO | SIGNAL | WARNING |ALARM}
Parameters in curly brackets describe the selectable range, underlined parameters show the default value after delivery or reset.

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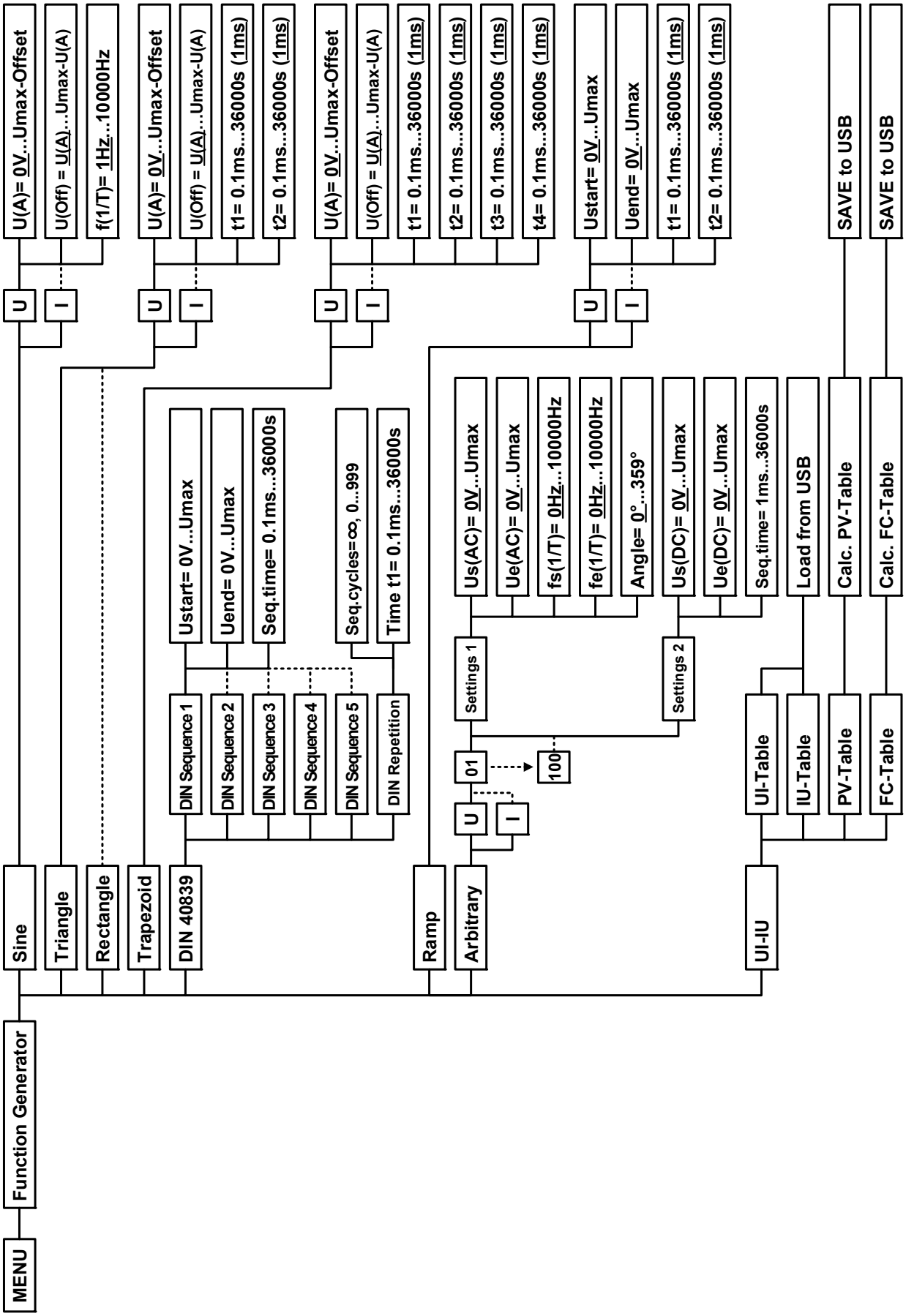
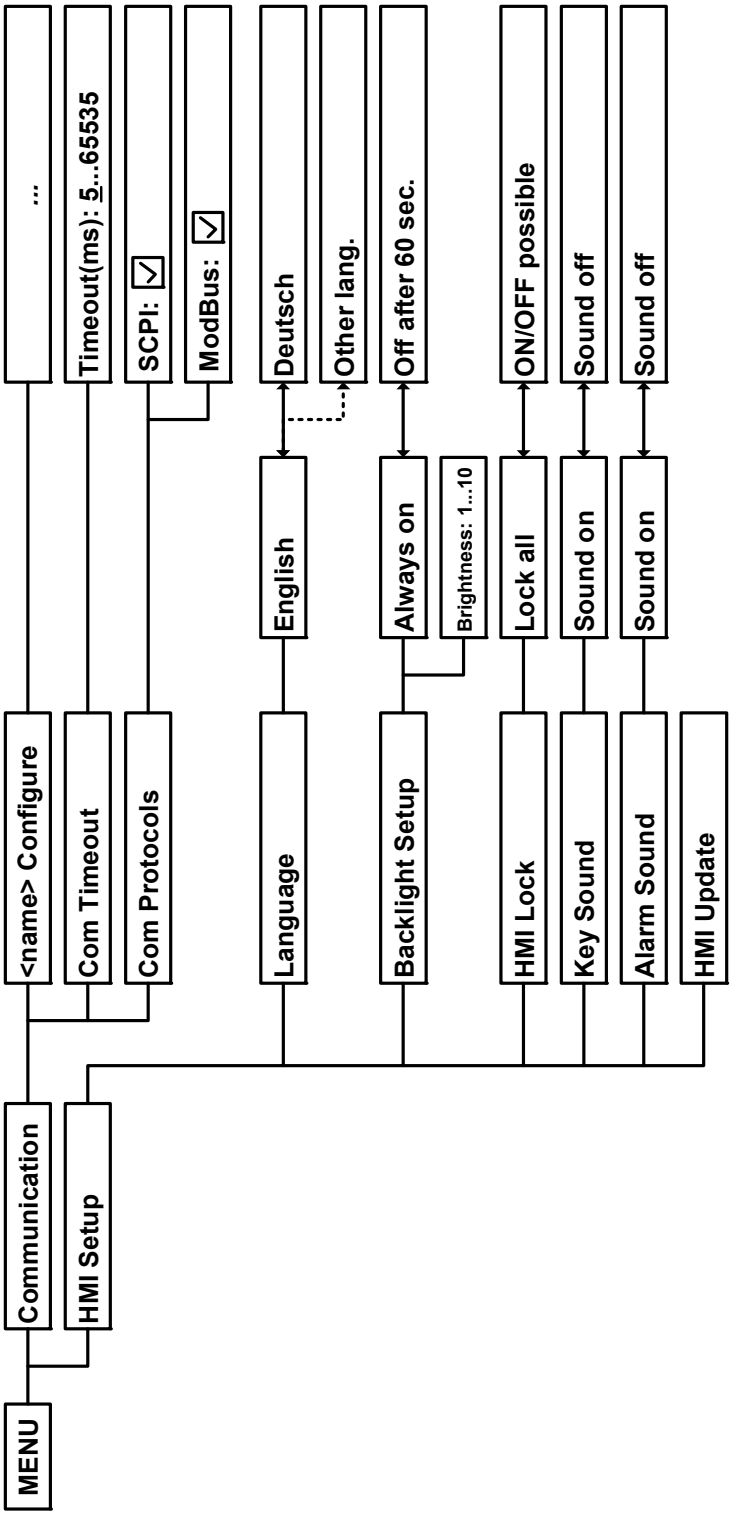


Parameters in curly brackets describe the selectable range, underlined parameters show the default value after delivery or reset.
Dotted lines mark multiple identical parameters like with U, I for "Sine", where U(A) changes to I(A) etc.



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3.4.3.1 Menu “General Settings”

Setting	P.	Description
Allow remote control	1	Selection “**NO**” means that the device cannot be remotely controlled over either the digital or analog interfaces. If remote control is not allowed, the status will be shown as “**local**” in the status area on the main display. See also section *1.9.6.1*
Analog interface range	1	Selects the voltage range for the analog set input values, actual output values and reference voltage output. • **0...5 V** = Range is 0...100% set /actual values, reference voltage 5 V • **0...10 V** = Range is 0...100% set /actual values, reference voltage 10 V See also section *“3.5.4. Remote control via the analog interface (AI)”*
Analog interface Rem-SB	2	Selects how the input pin “Rem-SB” of the analog interface shall be working regarding levels (see *“3.5.4.3. Analog interface specification”*) and logic: • **normal** = Levels and function as described in the table in *3.5.4.3* • **inverted** = Levels and function will be inverted Also see *“3.5.4.6. Application examples”*
Analog Rem-SB action	2	Selects the action on the DC output that is initiated when changing the level of analog input “Rem-SB”: • **DC OFF** = the pin can only be used to switch the DC output off • **DC AUTO** = the pin can be used to switch the DC output off and on again, if it has been switched on before at least from a different control location
Output after power ON	3	Determines the condition of the DC output after power-up. • **OFF** = DC output is always off after switching on the device. • **Restore** = DC output condition will be restored to the condition prior to switch off.
DC output after PF alarm	4	Determines how the DC output shall react after a power fail (PF) alarm has occurred: • **OFF** = DC output will be switched off and remain until user action • **Auto ON** = DC output will switch on again after the PF alarm cause is gone and if it was switched on before the alarm occurred
Enable R mode	5	Activates (“**Yes**”) or deactivates (“**No**”) the internal resistance control. If activated, the resistance set value can be adjusted on the main screen as additional value. For details refer to *“3.2.4. Internal resistance regulation”*
Calibrate device	6	Touch area “**Start**” starts a calibration routine (see *„4.4. Calibration“*), but only if the device is in U/I or U/P mode.
Reset device to defaults	7	Touch area “**Start**” will initiate a reset of all settings (HMI, profile etc.) to default values, as shown in the menu structure diagrams on the previous pages, and all set values to 0
Restart device	7	Will initiate a warm start of the device
Master-slave mode	8	Options “**MASTER**” or “**SLAVE**” enable the master-slave mode (MS) and set the selected position for the unit in the MS. This applies for the digital MS bus, the analog Share bus and two-quadrants operation. For details see sections *“3.10.1. Parallel operation in master-slave (MS)”* and *“3.10.4. Two quadrants operation (2QO)”.*
Device address	8	This is used to define the device address in master-slave operation between 1 and 15 (for slaves), while the master always has 0.

3.4.3.2 Menu “User Events”

See *“3.6.2.1 User defined events” on page 56.*

3.4.3.3 Menu “Profiles”

See *“3.8 Loading and saving a user profile” on page 57.*

3.4.3.4 Menu “Overview”

This menu page displays an overview of the set values (U, I, P or U, I, P, R) and alarm settings as well as settings limits. These can only be displayed, not changed.

3.4.3.5 Menu “About HW, SW...”

This menu page displays an overview of device relevant data such as serial number, article number etc., as well as an alarm history which lists the number of device alarms that probably occurred since the device has been powered.

3.4.3.6 Menu “Function Generator”

See *“3.9 The function generator” on page 58.*

3.4.3.7 Menu “Communication”

This submenu offers settings for digital communication via the optional or built-in interface. The button for the Anybus modules (Anybus symbol) or the optional GPIB port opens one or more settings pages, depending on the interface in use. There is furthermore an adjustable communication timeout, to make it possible to successfully transfer fragmented messages (data packets) using higher values. In the screen for “Com Protocols” you can enable both or disable one of the two supported communication protocols, ModBus and SCPI. This can help to avoid mixing both protocols and to receive unreadable messages, for example when expecting a SCPI response and getting a ModBus response instead.

For all Ethernet interfaces with two ports: “P1” is related to port 1 and “P2” to port 2, like printed on the module face. Two-port interfaces will use one IP only.

IF	Level 1	Level 2	Level 3	Description
Ethernet / ModBus-TCP, 1 & 2 Port	IP Settings	DHCP		The IF allows a DHCP server to allocate an IP address, a subnet mask and a gateway. If no DHCP server is in the network then network parameters will be set as defined in item “Manual”
		Manual	IP	This option is activated by default. An IP address can be maually allocated.
			Gateway	Here a gateway address can be allocated if required..
			Subnet	Here a subnet mask can be defined if the default subnet mask is not suitable.
		DNS 1		Here the addresses of the first and second Domain Name Servers (DNS) can be defined, if needed. A DNS is only necessary if the device has Internet access and should call Internet URLs, e.g. an internal eMail system, in order to send an eMail.
		DNS 2		
		Port		Range: 0...65535. Default ports: 5025 = Modbus RTU (all Ethernet interfaces) 502 = Modbus TCP (Modbus-TCP interface only)
	IP Com Settings P1	AUTO		Settings for the Ethernet port such as transmission speed are set automatically.
	IP Com Settings P2	Manual	Half dup	Manual selection for transmission speed (10MBit/100MBit) and duplex mode (full/half). It is recommended to use the “AUTO” option and only revert to “Manual” if these parameters fail.
			Full dup	
			10MBit	
			100MBit	
	Host name			Free choice of host name (default: Client)
	Domain name			Free choice of Domain (default: Workgroup)
	SMTP Settings	Server IP		Mail server address, used to send eMails via this mail server, in order to e.g. report an alarm.
		Username		Login to Mailserver, Username
		Password		Login to Mailserver, Password

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IF	Level 1	Description
Profibus DP	Node Address	Selection of the Profibus or node address of the device within range 1...125 via direct input
	Function Tag	String input box for a user-definable text which describes the Profibus slave function tag. Max. length: 32 characters
	Location Tag	String input box for a user-definable text which describes the Profibus slave location tag. Max. length: 22 characters
	Installation Date	String input box for a user-definable text which describes the Profibus slave installation date tag. Max. length: 40 characters
	Description	String input box for a user-definable text which describes the Profibus slave. Max. length: 54 characters

IF	Level 1	Description
RS232	-	The baud rate is selectable, other serial settings can't be changed and are defined like this: 8 data bits, 1 stop bit, parity = none Baud rates: 2400, 4800, 9600, 19200, 38400, 57600, 115200

IF	Level 1	Level 2	Level 3	Description
Profinet/IO, 1 & 2 Port	IP Settings	DHCP		The IF allows a DHCP server to allocate an IP address, a subnet mask and a gateway. If no DHCP server is in the network then network parameters will be set as defined in point "Manual"
		Manual	IP	This option is activated by default. An IP address can be maually allocated.
			Gateway	Here a gateway address can be allocated if required..
			Subnet	Here a subnet mask can be defined if the default subnet mask is not suitable.
		DNS 1		Here the addresses of the first and second Domain Name Servers (DNS) can be defined, if needed. A DNS is only necessary if the device has Internet access and should call Internet URLs, e.g. an internal eMail system, in order to send an eMail.
		DNS 2		
		Port		Range: 0...65535. Default ports: 5025 = Modbus RTU (for Modbus & SCPI)
	Host name			Free choice of host name (default: Client)
	Domain name			Free choice of Domain (default: Workgroup)
	SMTP Settings	Server IP		Mail server address, used to send eMails via this mail server, in order to e.g. report an alarm.
		Username		Login to Mailserver, Username
		Password		Login to Mailserver, Password
	Function Tag	String input box for a user-definable text which describes the Profinet slave function tag. Max. length: 32 characters		
	Location Tag	String input box for a user-definable text which describes the Profinet slave location tag. Max. length: 22 characters		
	Station Name	String input box for a user-definable text which describes the Profinet station name. Max. length: 54 characters		
	Description	String input box for a user-definable text which describes the Profibus slave. Max. length: 54 characters		
	Installation Date	String input box for a user-definable text which describes the Profibus slave installation date tag. Max. length: 40 characters		

IF	Level 1	Description
Devicenet	Node Address	Selection of the Devicenet node address in the range 0...63
	Baud Rate	Selection of the data communication speed with 125 kbps, 250 kbps or 500 kbps (1 kbps = 1024 Baud) as bus baud rate. Selection "AUTO" will let the slave device wait for the master to initiate bus traffic in order to detect the baud rate on the bus automatically

IF	Level 1	Level 2	Description
CANopen	Node Address		Selection of the CANopen node address in the range 1...127
	Baud Rate	AUTO	Automatic detection of the bus baud rate.(speed)
		LSS	Automatically sets baud rate and node address
		Manual	Manual selection of the baud rate that is used by the CANopen interface. Possible selections: 10 kbps, 20 kbps, 50 kbps, 100 kbps, 125 kbps, 250 kbps, 500 kbps, 800 kbps, 1Mbps (1Mbps = 1 Mbit/s, 10 kbps = 10 kbit/s)

IF	Level 1	Description
GPIB	Node Address	Adjustment of the GPIB node address (only with option 3W installed) in the range 1...30

Element	Description
Com Timeout	Communication timeout in milliseconds Default value: 5 Defines the max. time between two subsequent bytes or blocks of a transferred message. For more information about the timeout refer to the external programming documentation “Programming ModBus & SCPI”.
Com Protocols	Enables or disables SCPI or ModBus communication protocols for the device. The change is immediately effective after submitting it with ENTER button. Only one of both can be disabled.

3.4.3.8 Menu “HMI settings”

These settings refer exclusively to the control panel (HMI).

Element	Description
Languages	Selection of the display language. Currently (date: 09-20-2015) available are: German, English Additional languages (up to three can be integrated) can be implemented on demand and installed into the HMI via update. The default then would be English plus one or two additional language such as Italian, Spanish etc.
Backlight Setup	The choice here is whether the backlight remains permanently on or if it should be switched off when no input via screen or rotary knob is made for 60 s. As soon as input is made, the backlight returns automatically. Furthermore, the backlight intensity can be adjusted here.
HMI Lock	See *“3.7 Control panel (HMI) lock” on page 57.*
Key Sound	Activates or deactivates sounds when touching a touch area in the display. It can usefully signal that the action has been accepted.
Alarm Sound	Activates or deactivates the additional acoustic signal of an alarm or user defined event which has been set to “Action = ALARM”. See also *“3.6 Alarms and monitoring” on page 55.*
HMI Update	With this function the firmware for the control panel can be updated using a USB flash drive. For details refer to *“4.3.1 HMI firmware update” on page 80.*

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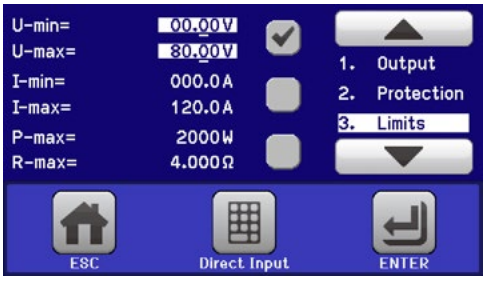
3.4.4 Adjustment limits

Adjustment limits are only effective on the related set values, no matter if using manual adjustment or remote control setting!

Defaults are that all set values (U, I, P, R) are adjustable from 0 to 100%.

The full range may be obstructive in some cases, especially for protection of applications against overvoltage. Therefore upper and lower limits for current (I) and voltage (U) can be set separately, which then limit the range of the adjustable set values.

For power (P) and resistance (R) only upper value limits can be set.



► How to configure the adjustment limits

1. On the main screen, tap SETTINGS to access the SETTINGS menu.
2. Tap the white arrows to select "**3. Limits".**
3. In each case a pair of upper and lower limits for U/I or the upper limit for P/R are assigned to the rotary knobs and can be adjusted. Tap the selection area for another choice .
4. Accept the settings with ENTER.

The set values can be entered directly using the ten-key pad. This appears when the touch area "Direct Input" is tapped (bottom centre)

The adjustment limits are coupled to the set values. It means, that the upper limit may not be set lower than the corresponding set value. Example: If you wish to set the limit for the power set value (P-max) to 6.00 kW while the currently adjusted power set value is 8.00 kW, then the set value first would have to be reduced to 6.00 kW or less, in order to set P-max down to 6.00 kW.

3.4.5 Changing the operating mode

In general, the manual operation of a PSI 9000 3U distinguishes between two resp. three operating modes, U/I and U/P and U/R, which are tied to set value input using the rotary knobs or ten-key pad. This assignment must be changed if one of the three resp. four set values is to be adjusted which is currently not accessible.

► How to change the operating mode:

1. Unless the device is device in remote control or the panel is locked, you switch the operation anytime. There are two options: either tap the depiction of the right-hand knob (see figure to the right) to change its assignment between I, P and R, which is displayed below the knob depiction, or
2. you directly tap on the coloured areas with the set values, like shown in the figure to the right. The unit next to the set values, when inverted, indicates the assignment of the knob. In the example in the figure it has U and P assigned, which means U/P mode.

Depending on the selection the right rotary knob will be assigned different setting values, the left knob is always assigned to the voltage.

In order to change the other values, like P or R while U/I is active, and without switching the assignment all the time, direct input can be used. See section 3.4.6.

The actual operating mode, which is only indicated while the DC output is switched on, solely depends only on the set values. For more information see section *"3.2. Operating modes".*

3.4.6 Manual adjustment of set values

The set values for voltage, current and power are the fundamental operating possibilities of a power supply and hence the two rotary knobs on the front of the device are always assigned to two of the the values in manual operation.

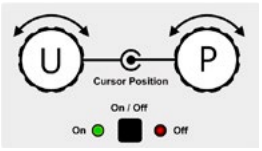
As a fourth value there is the internal resistance, for which the resistance mode (R mode) has to be activated in the MENU first. Refer to *"3.4.3. Configuration via MENU"* and *"3.2.4. Internal resistance regulation"* for details.

Set values can be entered manually in two ways: via **rotary knob** or **direct input**.

Entering a value changes it at any time, no matter if the output is switched on or off.

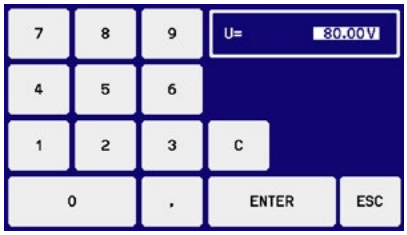
When adjusting set values, upper or lower limits may come into effect. See section "3.4.4. Adjustment limits". Once a limit is reached, the display will show a note like "Limit: U-mx" etc. for 1.5 seconds next to the adjusted value.

► How to adjust set values U, I, P or R with the rotary knobs



1. First check whether the value to be changed is assigned to one of the rotary knobs. The main screen displays the assignment as depicted in the figure to the right.
2. If, as shown in the example, the assignment is voltage (U, left) and power (P, right), and it is required to set the current, then the assignments can be changed by tapping this touch area. A set of selection fields then appears.
3. After successful selection, the desired value can be set within the defined limits. Selecting a digit is done by pushing the rotary knob which shifts the cursor clockwise (digit will be underlined):

►How to adjust values via direct input:



1. In the main screen, depending on the rotary knob assignment, values can be set for voltage (U), current (I), power (P) or resistance (R) via direct input by tapping on the set/actual value display areas, e.g in the uppermost area of voltage.
2. Enter the required value using the ten-key pad. Similar to a pocket calculator the key C clears the input.

   Decimal values are set by tapping the point key. For example, 54.3 V is set with 5 4 , 3 and ENTER.
3. The display reverts to the main page and the set values take effect.

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3.4.7 Switching the DC output on or off

The DC output of the device can be manually or remotely switched on and off. This can be restricted in manual operation by the control panel being locked.

Switching the DC output on during manual operation or digital remote control can be disabled by pin REM-SB of the built-in analog interface. For more information refer to 3.4.3.1 and example a) in 3.5.4.6.

► How to manually switch the DC output on or off

1. As long as the control panel is not fully locked press the button ON/OFF. Otherwise you are asked to disable the HMI lock first.
2. This button toggles between on and off, so long as a change is not restricted by an alarm or the device is locked in “remote”. The current condition is displayed as “Output ON” or “Output OFF”.

► How to remotely switch the DC output on or off via the analog interface

1. *See section “3.5.4 Remote control via the analog interface (AI)” on page 51.*

► How to remotely switch the DC output on or off via the digital interface

1. See the external documentation “Programming Guide ModBus & SCPI” if you are using custom software, or refer to the external documentation from LabView VIs or other software provided by the manufacturer.

3.5 Remote control

3.5.1 General

Remote control is possible via the built-in analog or USB port or via one of the optional interface modules (Any-Bus CompactCom, only with standard models of PSI 9000 3U series) or via the GPIB port (only with option 3W installed). Important here is that only the analog or one digital interface can be in control. It means that if, for example, an attempt were to be made to switch to remote control via the digital interface whilst analog remote control is active (Pin Remote = LOW) the device would report an error via the digital interface. In the opposite direction, a switch-over via Pin Remote would be ignored. In both cases, however, status monitoring and reading of values are always possible.

3.5.2 Control locations

Control locations are those locations from where the device is controlled. Essentially there are two: at the device (manual operation) and outside (remote control). The following locations are defined:

Displayed location	Description
-	If neither of the other locations is displayed then manual control is active and access from the analog and digital interfaces is allowed. This location is not explicitly displayed
Remote	Remote control via any interface is active
Local	Remote control is locked, only manual operation is allowed.

Remote control may be allowed or inhibited using the setting **"Allow remote control"** (see *"3.4.3.1. Menu "General Settings""*). In inhibited condition the status **"Local"** will be displayed top right. Activating the inhibit can be useful if the device is remotely controlled by software or some electronic device, but it is required to make adjustments at the device or deal with emergency, which would not be possible remotely.

Activating condition **"Local"** causes the following:

- If remote control via the digital interface is active ("**Remote**"). then remote control is immediately terminated and must be reactivated at the PC once "**Local**" is no longer active.
- If remote control is via the analog interface is active ("**Remote**") then remote operation is only interrupted until remote control is allowed again, because pin "Remote" continues to signal "remote control = on". Exception: if the level of pin "Remote" is changed to HIGH during the "**Local**" phase.

3.5.3 Remote control via a digital interface

3.5.3.1 Selecting an interface

The standard models of series PSI 9000 3U support, in addition to the built-in USB port, the following optional ly available interface modules:

Short ID	Art. nr.	Type	Ports	Description*
IF-AB-CANO	35400100	CANopen	1	CANopen slave with generic EDS
IF-AB-RS232	35400101	RS232	1	Standard RS232, serial
IF-AB-PBUS	35400103	Profibus	1	Profibus DP-V1 slave
IF-AB-ETH1P	35400104	Ethernet	1	Ethernet TCP
IF-AB-PNET1P	35400105	ProfiNet	1	Profinet DP-V1 slave
IF-AB-DNET	35400106	Devicenet	1	Full Devicenet slave
IF-AB-MBUS	35400107	ModBus TCP	1	ModBus-Protocol via Ethernet
IF-AB-ETH2P	35400108	Ethernet	2	Ethernet TCP, with switch
IF-AB-MBUS2P	35400109	ModBus TCP	2	ModBus-Protocol via Ethernet
IF-AB-PNET2P	35400110	ProfiNet	2	Profinet DP-V1 slave, with switch

* For technical details of the various modules see the extra documentation "Programming Guide Modbus & SCPI"

Models with option 3W installed offer an additional pre-installed GPIB port next to the default USB port.

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3.5.3.2 General information about the interface modules

With the standard models of series PSI 9000 3U, one of the plug-in and retrofittable modules listed in *3.5.3.1* can be installed. It can take over remote control of the device alternatively to the built-in USB type B on the back side or analog interface. For installation see section *"1.9.8. Interface module slot"* and separate documentation.

The modules require little or no settings for operation and can be directly used with their default configuration. All specific settings will be permanently stored such that, after changeover between the various models, no reconfiguration will be necessary.

3.5.3.3 Programming

Programming details for the interfaces, the communication protocols etc. are to be found in the documentation "Programming Guide ModBus & SCPI" which is supplied on the included CD or which is available as download from the manufacturer's website.

3.5.4 Remote control via the analog interface (AI)

3.5.4.1 General

The built-in, galvanically separated, 15-pole analog interface (short: AI) is on the back side of the device offers the following possibilities:

- Remote control of current, voltage, power and internal resistance*
- Remote status monitoring (CC/CP, CV)
- Remote alarm monitoring (OT, OVP)
- Remote monitoring of actual values
- Remote on/off switching of the DC output

Setting the **three** set values via the analog interface always takes place concurrently. It means, that for example the voltage can't be given via the AI and current and power set by the rotary knobs, or vice versa.

The OVP set value and other supervision (events) and alarm thresholds cannot be set via the AI and therefore must be adapted to the given situation before the AI is put in operation. Analog set values can be fed in by an external voltage or generated by the reference voltage on pin 3. As soon as remote control via the analog interface is activated, the values displayed will be those provided by the interface.

The AI can be operated in the common voltage ranges 0...5 V and 0...10 V in each case 0...100% of the nominal value. The selection of the voltage range can be done in the device setup. See section *"3.4.3. Configuration via MENU"* for details.

The reference voltage sent out from Pin 3 (VREF) will be adapted accordingly and is then:

0-5 V: Reference voltage = 5 V, 0...5 V set values (VSEL, CSEL, PSEL, RSEL) correspond to 0...100% nominal values, 0...100% actual values correspond to 0...5 V at the actual value outputs (CMON, VMON).

0-10 V: .Reference voltage = 10 V, 0...10 V set values (VSEL, CSEL, PSEL, RSEL) correspond to 0...100% nominal values, 0...100% actual values correspond to 0...10 V at the actual value outputs (CMON, VMON).

Input of excess set values (e.g. >5 V in selected 5 V range or >10 V in the 10 V range) are clipped by setting the set value at 100%.

Before you begin, please read. Important notes for use of the interface:

- Analog remote control of the device must be activated by switching pin "REMOTE" (5) first. Only exception is pin REM-SB, which can be used independently since KE firmware version 2.07
- Before the hardware is connected that will control the analog interface, it shall be checked that it can't provide voltage to the pins higher than specified
- Set value inputs, such as VSEL, CSEL, PSEL and RSEL (if R mode is activated), must not be left unconnected (i.e. floating)
- It is always required to provide all three resp. four set values at once. In case any of the set values is not used for adjustment, it can be tied to a defined level or connected to pin VREF (solder bridge or different), so it gives 100%

The analog interface is galvanically separated from DC output. Therefore do not connect any ground of the analog interface to the DC- or DC+ output!

* Unless the device has not already been delivered with KE firmware version 2.10, the internal resistance mode via analog interface requires retrofitting in the factory

3.5.4.2 Acknowledging device alarms

Device alarms (see *3.6.2*) are always indicated in the front display and some of them are also reported as signal on the analog interface socket (see *3.5.4.3*), for example the overvoltage alarm (OV), which is considered as critical.

In case of a device alarm occurring during remote control via analog interface, the DC output will be switched off the same way as in manual control. While alarms OT and OV can be monitored via the corresponding pins of the interface, other alarms like power fail (PF) can't. Those could only be monitored and detected via the actual values of voltage and current being all zero contrary to the set values.

Some device alarms (OV, OCP and OPP) have to be acknowledged, either by the user of the device or by the controlling unit. Also see *"3.6.2. Device alarm and event handling".* Acknowledgement is done with pin REM-SB switching the DC output off and on again, means a HIGH-LOW-HIGH edge (min. 50ms for LOW).

3.5.4.3 Analog interface specification

Pin	Name	Type*	Description	Default levels	Electrical properties
1	VSEL	AI	Set voltage value	0…10 V or. 0...5 V correspond to 0..100% of U_{Nom}	Accuracy < 0.2% *****
2	CSEL	AI	Set current value	0…10 V or. 0...5 V correspond to 0..100% of I_{Nom}	Input impedance R_i >40 k...100 k
3	VREF	AO	Reference voltage	10 V or 5 V	Tolerance < 0.2% at I_{max} = +5 mA Short-circuit-proof against AGND
4	DGND	POT	Ground for all digital signals		For control and status signals.
5	REMOTE	DI	Switching internal / remote control	Remote = LOW, U_{Low} <1 V Internal = HIGH, U_{High} >4 V Internal = Open	Voltage range = 0…30 V I_{Max} = -1 mA bei 5 V $U_{LOW\ to\ HIGH\ typ.}$ = 3 V Rec'd sender: Open collector against DGND
6	OT	DO	Overheating or power fail*** alarm	Alarm OT= HIGH, U_{High} > 4 V No Alarm OT= LOW, U_{Low} <1 V	Quasi open collector with pull-up against Vcc ** With 5 V on the pin max. flow +1 mA I_{Max} = -10 mA at U_{CE} = 0,3 V U_{Max} = 30 V Short-circuit-proof against DGND
7	RSEL (1	AI	Set internal resistance value	0…10 V or. 0...5 V correspond to 0..100% of R_{Max}	Accuracy < 0.2% ***** Input impedance R_i >40 k...100 k
8	PSEL	AI	Set power value	0…10 V or. 0...5 V correspond to 0..100% von P_{Nom}	Accuracy < 0.2% ***** Input impedance R_i >40 k...100 k
9	VMON	AO	Actual voltage	0…10 V or. 0...5 V correspond to 0..100% von U_{Nom}	Accuracy < 0.2% at I_{Max} = +2 mA Short-circuit-proof against AGND
10	CMON	AO	Actual current	0…10 V or. 0...5 V correspond to 0..100% von I_{Nom}	
11	AGND	POT	Ground for all analog signals		For -SEL, -MON, VREF Signals
12	R-ACTIVE	DI	R mode on / off	On = LOW, U_{Low} <1 V Off = HIGH, U_{High} >4 V Off = Open	Voltage range = 0…30 V I_{Max} = -1 mA bei 5 V $U_{LOW\ to\ HIGH\ typ.}$ = 3 V Rec'd sender: Open collector against DGND
13	REM-SB	DI	DC output OFF (DC output ON) (ACK alarms ****)	Off = LOW, U_{Low} <1 V On= HIGH, U_{High} >4 V On = Open	Voltage range = 0…30 V I_{Max} = +1 mA at 5 V Rec'd sender: Open collector against DGND
14	OVP	DO	Overvoltage alarm	Alarm OV = HIGH, U_{High} > 4 V No alarm OV = LOW, U_{Low} <1 V	Quasi open collector with pull-up against Vcc ** With 5 V on the pin max. flow +1 mA I_{Max} = -10 mA at U_{CE} = 0,3 V, U_{Max} = 30 V Short-circuit-proof against DGND
15	CV	DO	Constant voltage regulation active	CV = LOW, U_{Low} <1 V CC/CP/CR = HIGH, U_{High} >4 V	

* AI = Analog Input, AO = Analog Output, DI = Digital Input, DO = Digital Output, POT = Potential ** Internal Vcc approx. 10 V
*** Mains blackout, mains over- or undervoltage or PFC error **** Only during remote control ***** The error of a set value input adds to the general error of the related value on the DC output of the device

1) Unless the device has not already been delivered with KE firmware version 2.10, internal resistance mode via analog interface requires retrofitting in the factory

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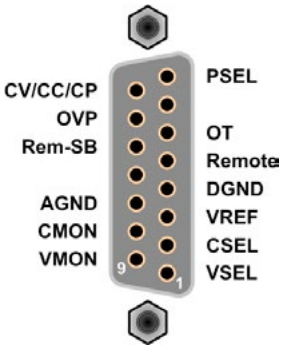
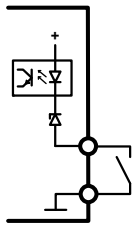
3.5.4.4 Overview of the Sub-D Socket



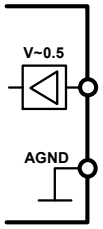
3.5.4.5 Simplified diagram of the pins



Digital Input (DI)

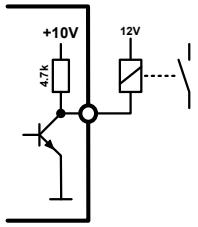
It requires to use a switch with low resistance (relay, switch, circuit breaker etc.) in order to send a clean signal to the DGND.

A digital output from a circuit or PLC may not be sufficient if not an “open collector”.



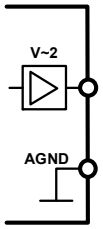
Analog Input (AI)

High resistance input (impedance >40 k....100 kΩ) for an OA circuit.



Digital Output (DO)

A quasi open collector, realised as high resistance pull-up against the internal supply. In condition LOW it can carry no load, merely switch, as shown in the diagram with a relay as example.

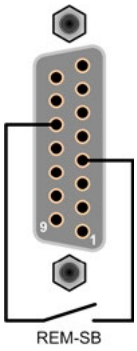


Analog Output (AO)

Output from an OA circuit, only minimally impedant. See specifications table above.

3.5.4.6 Application examples

a) Switching the DC output with pin “REM-SB”



A digital output, e.g. from a PLC, may be unable to cleanly pull down the pin as it may not be of low enough resistance. Check the specification of the controlling application. Also see pin diagrams above.

In remote control, pin REM-SB is be used to switch the DC output of the device on and off. From KE firmware version 2.07, this is also available without remote control being active.

It is recommended that a low resistance contact such as a switch, relay or transistor is used to switch the pin to ground (DGND).

Following situations can occur:

- **Remote control has been activated**

During remote control via analog interface, only pin “REM-SB” determines the states of the DC output, according to the levels definitions in *3.5.4.3*. The logical function and the default levels can be inverted by a parameter in the setup menu of the device. See *3.4.3.1*.

If the pin is unconnected or the connected contact is open, the pin will be HIGH. With parameter “Analog interface REM-SB” being set to “normal”, it requests “DC output on”. So when activating remote control, the DC output will instantly switch on.

- **Remote control is not active**

In this mode of operation pin “REM-SB” can serve as lock, preventing the DC output from being switched on by any means. This results in following possible situations:

DC-output	+	Pin “REM-SB”	+	Parameter “Rem-SB”	→	Behavior
is off	+	HIGH	+	normal	→	DC output not locked. It can be switched on by pushbutton “On/Off” (front panel) or via command from digital interface.
		LOW	+	inverted		
	+	HIGH	+	inverted	→	DC output locked. It can’t be switched on by pushbutton “On/Off” (front panel) or via command from digital interface. When trying to switch on, a popup in the display resp. an error message will be generated.
		LOW	+	normal		

In case the DC output is already switched on, toggling the pin will switch the DC output off, similar to what it does in analog remote control:

DC-output	→	Pin “REM-SB”	+	Parameter “Rem-SB”	→	Behavior
is on	→	HIGH	+	normal	→	DC output remains on, nothing is locked. It can be switched on or off by pushbutton or digital command.
		LOW	+	inverted		
	→	HIGH	+	inverted	→	DC output will be switched off and locked. Later it can be switched on again by toggling the pin. During lock, pushbutton or digital command can delete the request to switch on by pin.
		LOW	+	normal		

b) Remote control of current and power

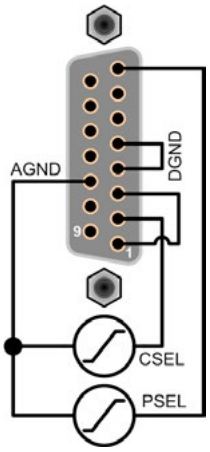
Requires remote control to be activated (Pin “Remote” = LOW)

The set values PSEL and CSEL are generated from, for example, the reference voltage VREF, using potentiometers for each. Hence the power supply can selectively work in current limiting or power limiting mode. According to the specification of max. 5 mA for the VREF output, potentiometers of at least 10 kΩ must be used.

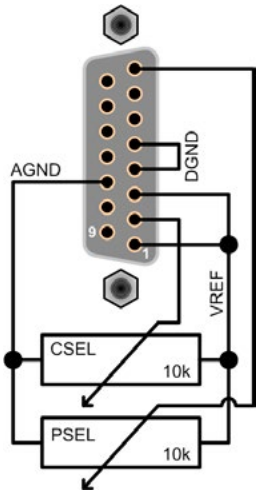
The voltage set value VSEL is directly connected to VREF and will thus be permanently 100%.

If the control voltage is fed in from an external source it is necessary to consider the input voltage ranges for set values (0...5 V oder 0...10 V).

Use of the input voltage range 0...5 V for 0...100% set value halves the effective resolution.



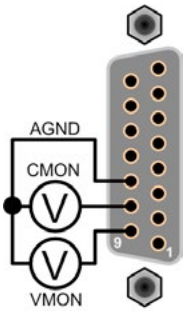
Example with external voltage source



Example with potentiometers

c) Reading actual values

The AI provides the DC input values as current and voltage monitor. These can be read using a standard multimeter or similar.



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3.6 Alarms and monitoring

3.6.1 Definition of terms

There is a clear distinction between device alarms (see *"3.3. Alarm conditions"*) such as overvoltage protection or overheating protection, and user defined events such as **OVD** (overvoltage detection). Whilst device alarms serve to protect the device by initially switching off the DC output, user defined events can switch off the DC output (Action = ALARM), but can also simply give an acoustic signal to make the user aware. The actions driven by user defined events can be selected:

Action	Impact	Example
NONE	User defined event is disabled.	
SIGNAL	On reaching the condition which triggers the event, the action SIGNAL will show a text message in the status area of the display.	
WARNING	On reaching the condition which triggers the event, the action WARNING will show a text message in the status area of the display and pop up an additional warning message.	
ALARM	On reaching the condition which triggers the event, the action ALARM will show a text message in the status area of the display with an additional alarm pop-up, and additionally emit an acoustic signal (if activated). Furthermore the DC output is switched off. Certain device alarms are also signalled to the analog interface or can be queried via the digital interface.	

3.6.2 Device alarm and event handling

A device alarm incident will usually lead to DC output switch-off, the appearance of a pop-up in the middle of the display and, if activated, an acoustic signal to make the user aware. An alarm must always be acknowledged.

► How to acknowledge an alarm in the display (during manual control)

1. If the alarm is indicated as a pop-up, tap **OK.**
2. If the alarm has already been acknowledged, but is still displayed in the status area, then first tap the status area to display the pop-up, and then acknowledge with **OK.**

In order to acknowledge an alarm during analog remote control, see *"3.5.4.2. Acknowledging device alarms"*. To acknowledge in digital remote, refer to the external documentation "Programming ModBus & SCPI".

Some device alarms are configurable:

Short	Meaning	Description	Range	Indication
OVP	**O**ver**V**oltage **P**rotection	Triggers an alarm if the DC output voltage reaches the defined threshold. The DC output will be switched off.	0 V...1.1*U_{Nom}	Display, analog & digital interface
OCP	**O**ver**C**urrent **P**rotection	Triggers an alarm if the DC output current reaches the defined threshold. The DC output will be switched off.	0 A...1.1*I_{Nom}	Display, digital interface
OPP	**O**ver**P**ower **P**rotection	Triggers an alarm if the DC output power reaches the defined threshold. The DC output will be switched off.	0 W...1.1*P_{Nom}	Display, digital interface

These device alarms can't be configured and are based on hardware:

Short	Meaning	Description	Indication
PF	**P**ower **F**ail	AC supply over- or undervoltage. Triggers an alarm if the AC supply is out of specification or when the device is cut from supply, for example when switching it off with the power switch. The DC output will be switched off.	Display, digital interface
OT	**O**ver**T**em**perature**	Triggers an alarm if the internal temperature reaches a certain limit. The DC output will be switched off.	Display, analog & digital interface
OTpre	**O**ver**T**em**perature** **pre**warning	Triggers an event of type **WARNING** if the internal temperature reaches a certain limit, lower than the one of **OT**. This event is intended to warn the operator that an **OT** alarm is imminent.	Display, digital interface

► How to configure the device alarms

1. Tap the touch area SETTINGS on the main screen.
2. On the right side tap the white arrow to select "**2. Protect**".
3. Set the limits for the equipment alarm relevant to your application if the default value of 110% is unsuitable.

> *The set values can be entered using the ten-key tab. This will appear by tapping the touch area that shows the rotary knob assignments.*

The user also has the possibility of selecting whether an additional acoustic signal will be sounded if an alarm or user defined event occurs.

► How to configure the alarm sound (also see "*3.4.3. Configuration via MENU*")

1. Tap the touch area MENU on the main screen
2. In the menu page, tap "**HMI Settings**"
3. In the following menu page, tap "**Alarm Sound**"
4. In the settings page select "**Sound on** " or "**Sound off**" and confirm with ENTER.

3.6.2.1 User defined events

The monitoring functions of the device can be configured for user defined events. Default is that this is deactivated (action = NONE). The following events can be configured independently and can, in each case, trigger the actions NONE, SIGNAL, WARNING or ALARM.

Alarm	Meaning	Description	Range
UVD	**U**nder**V**oltage **D**etection	Triggers an event if the output voltage falls below the defined threshold.	0 V...U_{Nom}
OVD	**O**ver**V**oltage **D**etection	Triggers an event if the output voltage reaches the defined threshold.	0 V...U_{Nom}
UCD	**U**nder**C**urrent **D**etection	Triggers an event if the output current falls below the defined threshold.	0 A...I_{Nom}
OCD	**O**ver**C**urrent **D**etection	Triggers an event if the output current reaches the defined threshold.	0 A...I_{Nom}
OPD	**O**ver**P**ower **D**etection	Triggers an event if the output power reaches the defined threshold.	0 W...P_{Nom}

> *These events should not be confused with alarms such as OT and OVP which are for device protection. User defined events can, however, if set to action ALARM, switch off the DC output and thus protect the load, like a sensitive electronic application.*

► How to configure user defined events

1. Tap the touch area SETTINGS on the main screen..
2. On the right side tap the white arrows ▲ ▼ to select "**4.1 Event U**" or "**4.2 Event I**" or "**4.3 Event P**".
3. Set the monitoring limits with the left hand rotary knob and the triggered action with the right hand knob relevant to the application (also see *"3.6.1. Definition of terms"*).
4. Accept the settings with ENTER.

As soon as an event is set up with an action other than "NONE" and with accepted settings, an incident can occur whether the DC output is switched on or off. On leaving the pages "**User events**" or "**Settings**" an event can be directly displayed.

> *User events are an integral part of the actual user profile. Thus, if another user profile, or the default profile, is selected and used, the events will be either differently or not configured.*

> *The set values can be entered using the ten-key tab. This will appear by tapping the touch area on the particular page, e.g. "**4.1 Event U**", showing the rotary knob assignments.*

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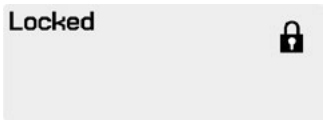
3.7 Control panel (HMI) lock

In order to avoid the accidental alteration of a value during manual operation the rotary knobs or the touchscreen can be locked so that no alteration of values will be accepted without prior unlocking.

► How to lock the HMI



1. In the main page, tap the lock symbol (upper right corner).
2. In the settings page you can select between the complete HMI (“**Lock all**”) lock or except for the On/Off button (“**ON/OFF possible**”)
3. Activate the lock with . The status “**Locked**” as shown in the figure to the right.

If an attempt is made to alter something whilst the HMI is locked, a requester appears in the display asking if the lock should be disabled.

► How to unlock the HMI

1. Tap any part of the touchscreen of the locked HMI, or turn one of the rotary knobs or press the button “On/Off” (in complete lock situation).
2. This request pop-up will appear:

.
3. Unlock the HMI by tapping on “Tap to unlock” within 5 seconds, otherwise the pop-up will disappear and the HMI remains locked.

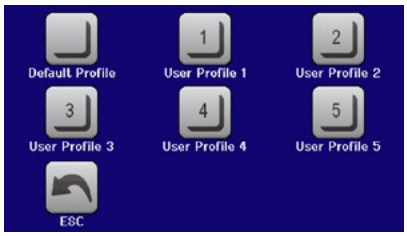
3.8 Loading and saving a user profile

The menu “**Profiles**” serves to select between a default profile and up to 5 user profiles. A profile is a collection of all settings and set values. Upon delivery, or after a reset, all 6 profiles have the same settings and all set values are 0. If the user changes settings or sets target values then these create a working profile which can be saved to one of the 5 user profiles. These profiles or the default one can then be switched. The default profile is read-only.

The purpose of a profile is to load a set of set values, settings limits and monitoring thresholds quickly without having to readjust these. As all HMI settings are saved in the profile, including language, a profile change can also be accompanied by a change in HMI language.

On calling up the menu page and selecting a profile the most important settings can be seen, but not changed.

► How to save the current values and settings as a user profile:



1. Tap the touch area MENU on the main screen
2. In the menu page, tap .
3. In the selection screen (right) choose between user profile 1-5 in which the settings are to be saved. The profile will then be displayed and the values can be checked, but not changed.
4. Save using the touch area .

3.9 The function generator

3.9.1 Introduction

The built-in **function generator** (short: **FG**) is able to create various signal forms and apply these to the set value of voltage or current.

In manual operation, all generator functions are available for access on the front panel. In remote control, only the customisable **arbitrary** generator and a **XY** function are available. The arbitrary generator can replicate all manually serviceable functions, except UI and IU. For those, the XY function is assigned.

The following functions are retrievable, configurable and controllable:

Function	Applicable to	Short description
Sine wave	U, I	Sine wave generation with adjustable amplitude, offset and frequency
Triangle	U, I	Triangular wave signal generation with adjustable amplitude, offset, gain and decay times
Rectangular	U, I	Rectangular wave signal generation with adjustable amplitude, offset and duty cycle
Trapezoid	U, I	Trapezoidal wave signal generation with adjustable amplitude, offset, rise time, pulse time, fall time, idle time
DIN 40839	-	Simulated automobile engine start curve according to DIN 40839 / EN ISO 7637, split into 5 curve sequences, each with a start voltage, final voltage and time
Arbitrary	U, I	Generation of a process with up to 100 freely configurable steps, each with a start and end value (AC/DC), start and end frequency, phase angle and total duration
Ramp	U, I	Generation of a linear rise or fall ramp with start and end values and time before and after the ramp
UI, IU PV, FC	-	Table (.csv) with values for U or I, uploaded from a USB flash drive, as well as functions to simulate a solar panel (PV function) or fuel cells (FC function)

Whilst R mode is activated, access to the function generator is not available.

3.9.2 General

3.9.2.1 Limitations

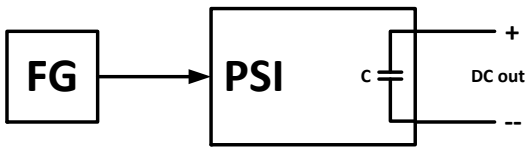
The function generator is not accessible, neither for manual acces, nor for remote control, if

- master-slave mode has been activated and the device was configured as slave.
- resistance modes (R/I adjustment mode, also called UIR mode) is active.

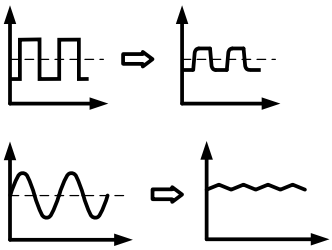
3.9.2.2 Principle

The power supply unit cannot be considered as high power function generator, because it is only post-connected to the FG. Thus the typical characteristics of a voltage and current source remain. Rise and fall times, caused by capacitor charge/discharge, affect the resulting signal on the DC output. While the FG is able to generate a sine wave with 1000 Hz or more, the power supply will never be able to follow the generated signal 1:1.

Depiction of principle:



Affect of the power supply on functions:



The resulting wave form on the DC output heavily depends on the frequency of the selected wave, its amplitude and power supply model. The effects of the power supply on the wave can only be partially compensated. A high-speed modification, like offered with **option HS** (see *"1.9.5. Options"*), can help to decrease rise and fall times. This has a positive impact on periodic functions like rectangle or sine wave. Alternatively, the resulting wave form on the DC output can also be improved by attaching additional load (fixed & ohmic or variable & electronic).

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3.9.2.3 Resolution of X (time) and Y (amplitude)

The device can set 4096 steps between 0 ... 100% of nominal value. The intervals to create a linear or other rise/fall are calculated depending on the amplitude and then set.

If the amplitude is very low and the time long, only few intervals will be set as otherwise many identical values will be set one after another, generating a staircase effect.

3.9.2.4 Possible technical complications

Operation of switching mode power supplies as a voltage source can, when applying a function to the output voltage, lead to damage of the output capacitors due to continuous charging/discharging which causes overheating. Furthermore the actual voltage progression may differ from what's expected.

3.9.3 Method of operation

In order to understand how the function generator works and how the value settings interact, the following should be noted:

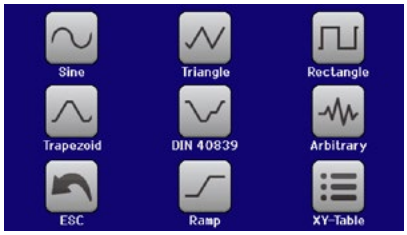
The device operates, including in function generator mode,always with the three set values U,I and P.

The selected function can be used on one of both the values U or I, the other two are then constants and have a limiting effect. That means if, for example, a voltage of 10 V is set for the DC output, a load is connected and a sine wave function should operate on the current with an amplitude of 20 A and offset 20 A, then the function generator will create a sine wave progression of current between 0 A (min) and 40 A (max), which will result in an output power between 0 W (min) and 400 W (max).The output power, however, is limited to its set value. If this were 300 W then, in this case, the current would be limited to 30 A and, if clamped to an oscilloscope, it would be seen to be capped at 30 A and never achieve the target of 40 A.

3.9.4 Manual operation

3.9.4.1 Function selection and control

Via the touchscreen one of the functions described above can be called up, configured and controlled. Selection and configuration are only possible when the output is switched off.



► How to select a function and adjust parameters

1. Tap the touch area MENU on the main screen.
   If the menu does not appear it is because the DC output is still switched on or the touch area is locked due to the device being possibly in remote control.
2. In the menu overview tap on the touch area

and then on the desired function.
   Note: this touch area is locked in master-slave mode or in R mode (adjustable resistance).
3. Depending on the choice of function there follows a request to which value the function generator is going to be applied: U or I.
4. Adjust the parameters as you desire, like offset, amplitude and frequency for a sine wave, for example.
5. Adjust the overall limits of voltage, current and power, which you can access with touch area

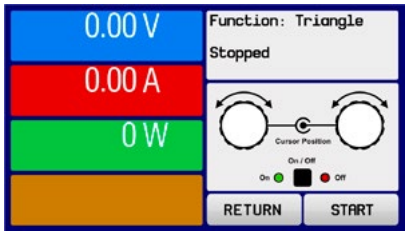
.

> *When entering function generator mode those limits are reset to safe values, which can prevent the function from working at all. For example, if you apply the selected function to the output current, then the overall current limit should not interfere and should at least be as high as offset + amplitude.*

Setting the various functions is described below.

After setting it up, the function can be loaded.

► How to load a function



1. After setting the values for the required signal generation, tap on the touch area

.

The device will then load the data into the internal controller and changes the display. Shortly afterwards the static values are set (power and voltage or current), the DC output is switched on and the touch area START enabled. Only then can the function be started.

The static values are applied to the DC output immediately after loading the function, because it switches the DC output on automatically in order to set the start situation. They represent start and end values for the progress of the function, so that tit doesn't need to start from 0. Only exception: when applying a function to the current (I), there is no adjustable static current value, so the function would always start from 0 A.

► How to start and stop a function

1. The function can be started either by tapping START or pushing the "On/Off" button, if the DC output is currently switched off. The function then starts immediately. In case START is used while the DC output is still switched off, the DC output will be switched on automatically.

*During the progress of the functions **sine wave, rectangular wave, triangular wave, trapezoidal wave** or **ramp*** only the actual values of U, I and P are displayed*.*

2. The function can be **stop**ped either by tapping STOP or operating the "On/Off" button. However, there is a difference:

   a) The STOP button stops only the function, the DC output remains ON with the static values.

   b) The "On/Off" button stops the function and switches off the DC output.

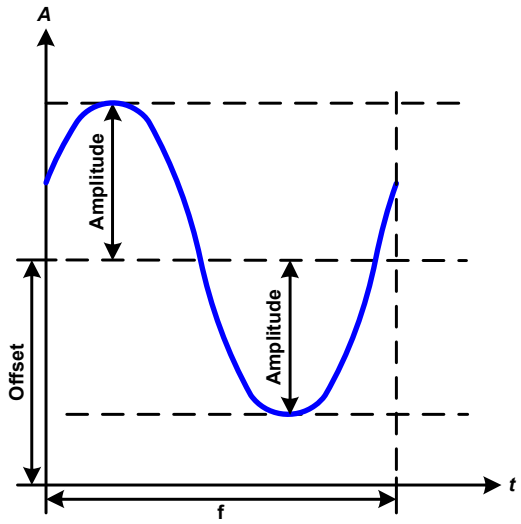
A device alarm such as overvoltage, overheating or power failure stops the function progress automatically and the DC output is switched off.

3.9.5 Sine wave function

The following parameters can be configured for a sine wave function:

Value	Range	Description
I(A), U(A)	0...(Nominal value - (Off)) of U, I	A = Amplitude of the signal to be generated
I(Off), U(Off)	(A)...(Nominal value - (A)) of U, I	Off = Offset, based on the zero point of the mathematic sine curve, may not be smaller than the amplitude.
f (1/t)	1...10000 Hz	Static frequency of the signal to be generated

Schematic diagram:



Application and result:

A normal sine wave signal is generated and applied to the selected set value, e.g. voltage (U). At a constant load resistance, the output voltage and thus also the output current will follow a sine wave.

For calculating the maximum power output the amplitude and offset values for the current have to be added.

Example: an output voltage of 100 V is set together with sin(I) with an amplitude of 30 A and an offset of 50 A. The resulting maximum power output is then achieved at the highest point of the sine wave and is (30 A + 50 A) * 100 V = 8000 W.

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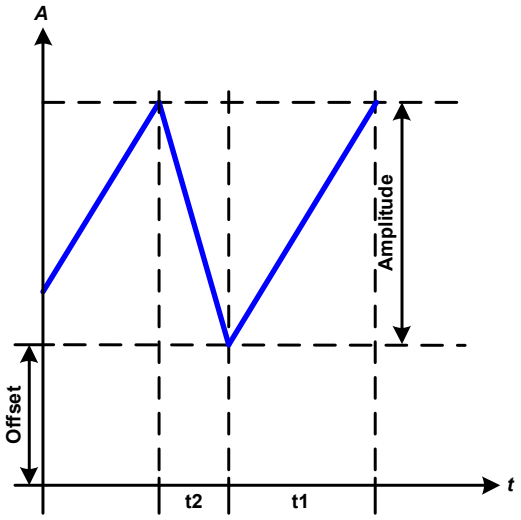
3.9.6 Triangular function

The following parameters can be configured for a triangular wave function:

Value	Range	Description
I(A), U(A)	0...(Nominal value - (Off)) of U, I	A = Amplitude of the signal to be generated
I(Off), U(Off)	0...(Nominal value - (A)) of U, I	Off = Offset, based on the foot of the triangular wave
t1	0.1 ms...36000 s	Rising edge time Δt of the triangular wave signal
t2	0.1 ms...36000 s	Falling edge time Δt of the triangular wave signal

Schematic diagram:



Application and result:

A triangular wave signal for output current (only effective in current limiting) or output voltage is generated. The positive and negative slope times can be set independently.

The offset shifts the signal on the Y-axis.

The sum of the intervals t1 and t2 gives the cycle time and its reciprocal is the frequency.

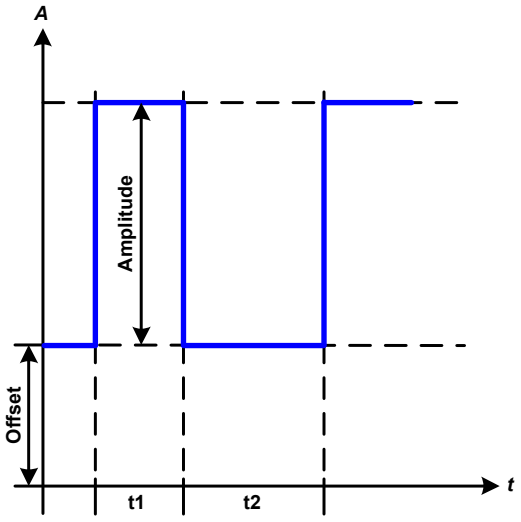
Example: a frequency of 10 Hz is required and would lead to periodic duration of 100 ms. This 100 ms can be freely allocated to t1 and t2, e.g. 50 ms:50 ms (isosceles triangle) or 99.9 ms:0.1 ms (right-angled triangle or sawtooth).

3.9.7 Rectangular function

The following parameters can be configured for a rectangular wave function:

Value	Range	Description
I(A), U(A)	0...(Nominal value - (Off)) of U, I	A = Amplitude of the signal to be generated
I(Off), U(Off)	0...(Nominal value - (A)) of U, I	Off = Offset, based on the foot of the rectangular wave
t1	0.1 ms...36000 s	Time (pulse width) of the upper level (amplitude)
t2	0.1 ms...36000 s	Time (pause width) of the lower level (offset)

Schematic diagram:



Application and result:

A rectangular or square wave signal for input current (direct) or input voltage (indirect) is generated. The intervals t1 and t2 define how long the value of the amplitude (pulse) and how long the value of the offset (pause) are effective.

The offset shifts the signal on the Y axis.

Intervals t1 and t2 can be used to define a duty cycle. The sum of t1 and t2 gives the period and its reciprocal is the frequency.

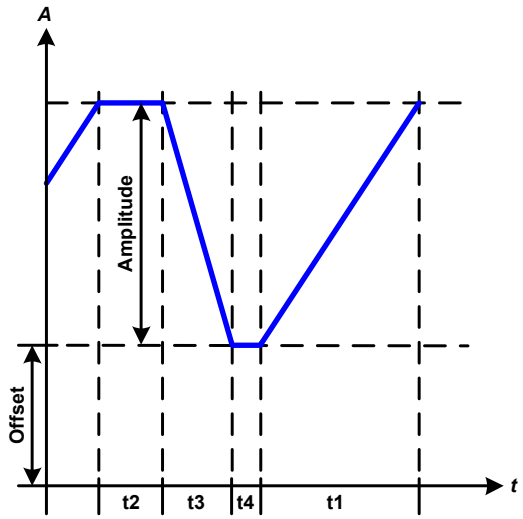
Example: a rectangular wave signal of 25 Hz and a duty cycle of 80% are required. The sum of t1 and t2, the period, is 1/25 Hz = 40 ms. For a duty cycle of 80% the pulse time (t1) is 40 ms*0.8 = 32 ms and the pause time (t2) is 8 ms

3.9.8 Trapezoidal function

The following parameters can be configured for a trapezoidal curve function:

Value	Range	Description
I(A), U(A)	0...(Nominal value - (Off)) of U, I	A = Amplitude of the signal to be generated
I(Off), U(Off)	0...(Nominal value - (A)) of U, I	Off = Offset, based on the foot of the trapezium
t1	0.1 ms...36000 s	Time for the positive slope of the trapezoidal wave signal.
t2	0.1 ms...36000 s	Time for the top value of the trapezoidal wave signal.
t3	0.1 ms...36000 s	Time for the negative slope of the trapezoidal wave signal.
t4	0.1 ms...36000 s	Time for the base value (offset) of the trapezoidal wave signal

Schematic diagram:



Application and result:

Here a trapezoidal signal can be applied to a set value of U or I. The slopes of the trapezium can be different by setting different times for gain and decay.

The periodic duration and repetition frequency are the result of four time elements. With suitable settings the trapezium can be deformed to a triangular or rectangular wave. It has, therefore, universal use.

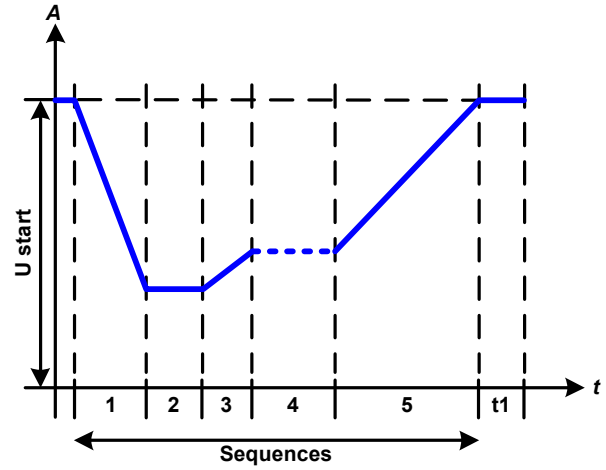
3.9.9 DIN 40839 function

This function is based on the curve defined in DIN 40839 / EN ISO 7637 (test impulse 4), and is only applicable to voltage. It shall replicate the progress of automobile battery voltage during engine starting. The curve is divided into 5 sequences (see diagram below) which each have the same parameters. The standard values from the DIN are set already as default values for the five sequences.

The following parameters can be configured for the DIN40839 function:

Value	Range	Seq	Description
Ustart	0...Nominal value of U	1-5	Start voltage of the ramp
Uend	0...Nominal value of U	1-5	End voltage of the ramp
Seq.time	0.1 ms...36000 s	1-5	Time of the ramp
Seq.cycles	∞ or 1...999	-	Number of repetitions of the entire curve
Time t1	0.1 ms...36000 s	-	Time after cycle before repetition (cycle <> 1)

Schematic diagram:



Application and result:

The function is not suitable for standalone operation of a power supply, but optimal for power supply in conjunction with an electronic load, for example one from ELR 9000 series. The load acts as a sink for the rapid fall of the output voltage of the power supply enabling the output voltage progress to follow the DIN curve.

The curve conforms to test impulse 4 of the DIN. With suitable settings, other test impulses can be simulated. If the curve in sequence 4 should be a sine wave, then these 5 sequences have to be transferred to the arbitrary generator.

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3.9.10 Arbitrary function

The arbitrary (freely definable) function offers the user further scope. Up to 100 sequences are available for use for current I and voltage U, all of which have the same parameters but which can be differently configured so that a complex function process can be built up. The 100 sequences can run one after another in a sequence block, and this sequence block can then be repeated many times or endlessly. From the 100 sequences a block can be freely defined to run from sequence x to sequence y. A sequence or sequence block acts only on current or voltage, thus a mix of assignment to current I or voltage U is not possible.

The arbitrary curve overlays a linear progression (DC) with a sine curve (AC), whose amplitude and frequency are shaped between start and end values. If the start frequency (fs) = end frequency (fe) = 0 Hz, the AC values have no impact and only the DC part is effective. Each sequence is allocated a sequence time in which the AC/DC curve from start to finish will be generated.

The following parameters can be configured for each sequence in the arbitrary function (the table lists parameters for current, for voltage it would be Us, Ue etc.)

Value	Range	Seq.	Description
Is(AC)	0...50% Nominal value I	1-100	Start amplitude of the sine wave part of the curve
Ie(AC)	0...50% Nominal value I	1-100	End amplitude of the sine wave part of the curve
fs(1/T)	0 Hz...10000 Hz	1-100	Start frequency of the sine wave part of the curve (AC)
fe(1/T)	0 Hz...10000 Hz	1-100	End frequency of the sine wave part of the curve (AC)
Angle	0°...359°	1-100	Start angle of the sine wave part of the curve (AC)
Is(DC)	Is(AC)...(Nominal value - Is(AC)) of I	1-100	Start value of the DC part of the curve
Ie(DC)	Ie(AC)...(Nominal value - Ie(AC)) of I	1-100	End value of the DC part of the curve
Seq.time	0.1 ms...36000 s	1-100	Time for the selected sequence

The sequence time (seq. time) and the start and end frequency are related. The minimum value for Δf/s is 9.3. Thus, for example, a setting of fs = 1 Hz, fe = 11 Hz and Seq.time = 5 s would not be accepted as Δf/s is only 2. A seq. time of 1 s would be accepted, or, if the time remains at 5 s, then fe = 51 Hz must be set.

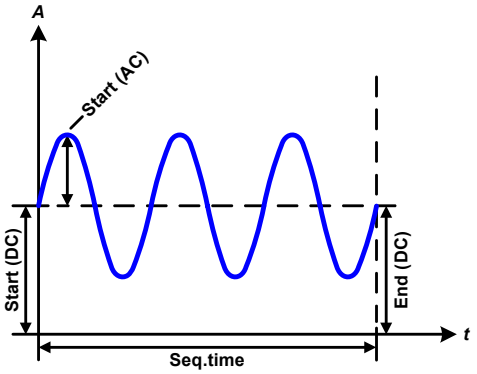
The amplitude change between start and end is related to the sequence time. A minimal change over an extended time is not possible and in such a case the device will report an inapplicable setting.

After the settings for the selected sequence are accepted with SAVE, further sequences can be configured. If the button NEXT is touched a second settings screen appears in which global settings for all 100 sequences are displayed.

The following parameters can be set for the total run of an arbitrary function:

Value	Range	Description
Start seq.	1...End seq.	First sequence in the sequence block
End seq.	100...Start seq.	Last sequence in the sequence block
Seq. Cycles	∞ orr 1...999	Number of cycles of the sequence block

Schematic diagram:



Applications and results:

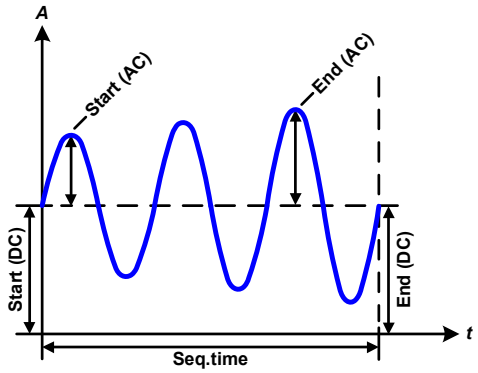
Example 1

Focussing 1 cycle of 1 sequence from 100:

DC values for start and end are the same, also the AC amplitude. With a frequency >0 a sine wave progression of the set value is generated with a defined amplitude, frequency and Y-shift (offset, DC value at start and end)

The number of sine waves per cycle depend on the sequence time and the frequency. If the sequence time were 1 s and the frequency 1 Hz, there would be exactly 1 sine wave. If the time were 0.5 s at the same frequency, there would only be a half sine wave.

Schematic diagram:

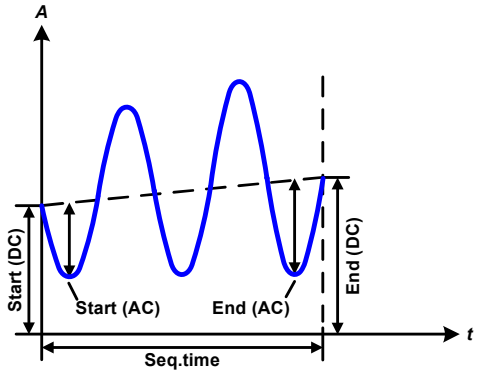


Applications and results:

Example 2

Focussing 1 cycle of 1 sequence from 100:

The DC values at start and end are the same but the AC (amplitude) not. The end value is higher than the start so that the amplitude increases with each new half sine wave continuously through the sequence. This, of course, only if the sequence time and frequency allow for multiple waves to be created. e.g. for f=1 Hz and Seq. time = 3 s, three complete waves would be generated (for angle = 0°) and reciprocally the same for f=3 s and Seq. time=1 s.

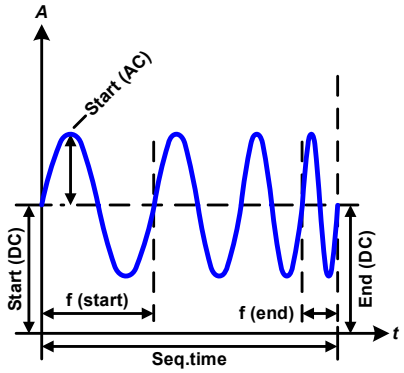


Example 3

Focussing 1 cycle of 1 sequence from 100:

The DC values at start and end are unequal, as are also the AC values. In both cases the end value is higher than the start so that the offset increases from start to end (DC) and the amplitude also with each new half sine wave.

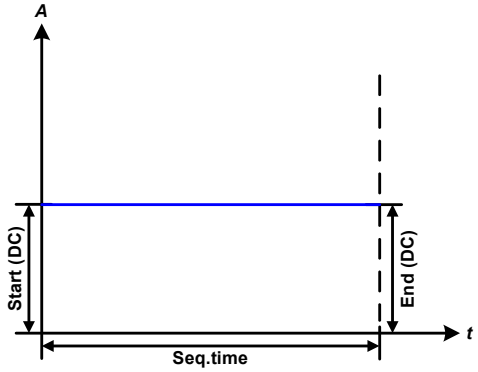
Additionally the first sine wave starts with a negative half wave because the angle is set at 180°. The start angle can be shifted at will in 1° steps between 0° and 359°.



Example 4

Focussing 1 cycle of 1 sequence from 100:

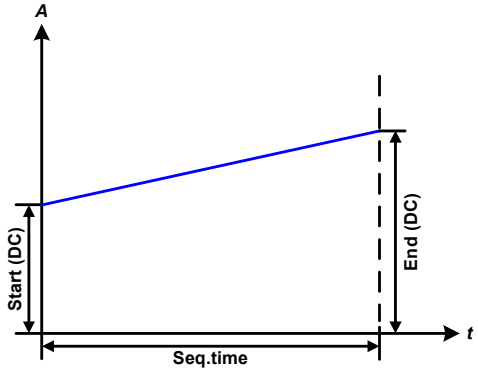
Similar to example 1 but with another end frequency. Here this is shown as higher than the start frequency. This impacts the period of the sine waves such that each new wave will be shorter over the total span of the sequence time.



Example 5

Focussing 1 cycle of 1 sequence from 100:

Similar to example 1 but with a start and end frequency of 0 Hz. Without a frequency no sine wave part (AC) will be created and only the DC settings will be effective. A ramp with a horizontal progression is generated.



Example 6

Focussing 1 cycle of 1 sequence from 100:

Similar to example 1 but with a start and end frequency of 0 Hz. Without a frequency no sine wave part (AC) will be created and only the DC settings will be effective. Here start and end values are unequal and a steadily increasing ramp is generated.

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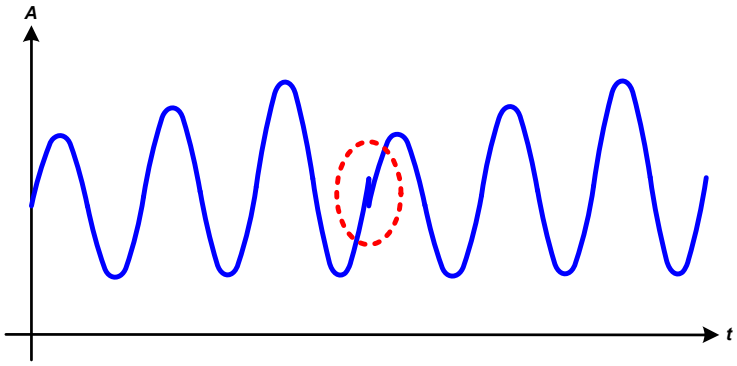
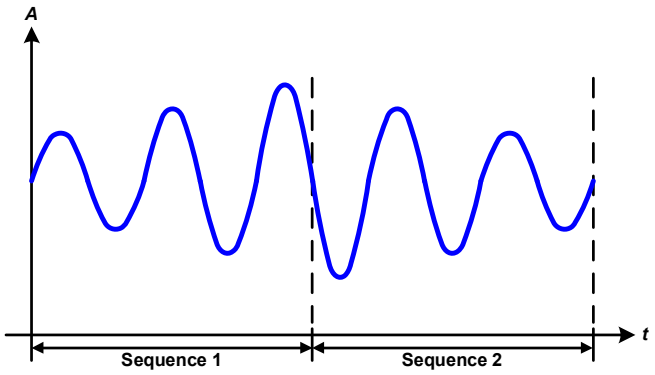
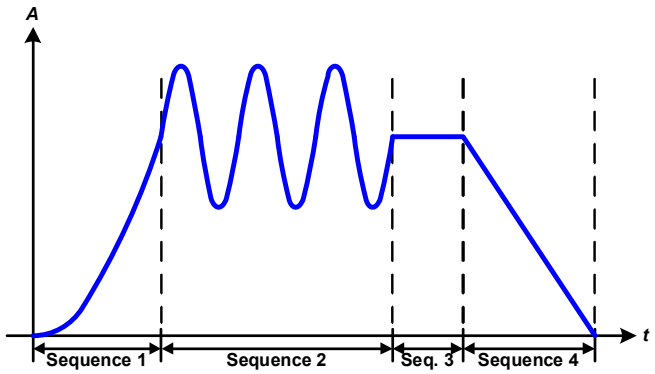
By linking together a number of differently configured sequences, complex progressions can be created. Smart configuration of the arbitrary generator can be used to match triangular, sine, rectangular or trapezoidal wave functions and thus, e.g. a sequence of rectangular waves with differing amplitudes or duty cycles could be produced.

Assignment to either U or I makes up to 100 sequences available for either current or voltage but not a mix. That means that a sequence X which produces a ramp up on current cannot be followed by sequence Y which applies a sine wave to the voltage.

Schematic diagram:







Applications and results:

Example 7

Focussing 1 cycle of 2 sequences from 100:

A sequence configured as in example 3 is run. As the settings demand that the end offset (DC) is higher than the start, the second sequence run will revert to the same start level as the first, regardless of the values achieved at the end of the first run. This can produce a discontinuity in the total progression (marked in red) which may only be compensated with careful choice of settings.

Example 8

Focussing 1 cycle of 2 sequences from 100:

Two sequences run consecutively. The first generates a sine wave with increasing amplitude, the second with a decreasing amplitude. Together they produce a progression as shown left. In order to ensure that the maximum wave in the middle occurs only once, the first sequence must end with a positive half wave and the second start with a negative half wave as shown in the diagram..

Example 9

Focussing 1 cycle of 4 sequences from 100:

Sequence 1: 1/4th sine wave (angle = 270°)

Sequence 2: 3 Sine waves (relationship frequency to sequence time: 1:3)

Sequence 3: Horizontal ramp (f = 0)

Sequence 4: Falling ramp (f = 0)

3.9.10.1 Loading and saving the arbitrary function

The 100 sequences of the arbitrary function, which can be manually configured with the control panel of the device and which are applicable either to voltage (U) or current (I), can be saved to or loaded from a common USB flash drive via the front side USB port. Generally, all 100 sequences are saved or loaded using a text file of type CSV (semicolon separator), which represents a table of values.

In order to load a sequence table for the arbitrary generator, following requirements have to be met:

- The table must contain exactly 100 rows with 8 subsequent values (8 columns, separated by semicolons) and must not have gaps
- The files must be stored inside a folder called HMI_FILES which has to be in the root of the USB drive
- The file name must always start with WAVE_U or WAVE_I (not case-sensitive)
- Values with decimal places must use the comma as decimal separator
- All values in every row and column have to be within the specified range (see below)
- The columns in the table have to be in a defined order which must not be changed

Following value ranges are given for use in the table, related to the manual configuration of the arbitrary generator (column headers like in Excel):

Column	Parameter	Range
A	AC Start	0...50% U or I
B	AC End	0...50% U or I
C	Frequency Start	0...1000 Hz
D	Frequency End	0...1000 Hz
E	Start angle AC	0...359°
F	DC Start	0...(Nominal value of U or I) - AC Start
G	DC End	0...(Nominal value of U or I) - AC End
H	Time in µs	100...36.000.000.000 (36 billion µs)

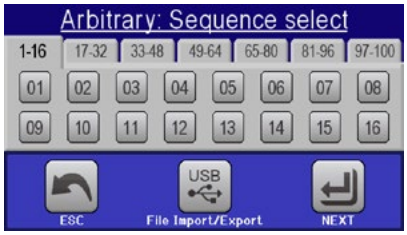
For details about the parameter and the arbitrary function refer to *„3.9.10. Arbitrary function“.*

Example CSV:

	A	B	C	D	E	F	G	H
1	20,00	30,00	5	5	90	50,00	50,00	50000000
2	30,00	20,00	5	5	90	50,00	50,00	30000000
3	0,00	0,00	0	0	0	0,00	0,00	1000
4	0,00	0,00	0	0	0	0,00	0,00	1000
5	0,00	0,00	0	0	0	0,00	0,00	1000
6	0,00	0,00	0	0	0	0,00	0,00	1000

The example shows that only the first two sequences are configured, while all others are set to default values. The table could be loaded as WAVE_U or WAVE_I when using, for example, the model PSI 9080-170 3U, because the values would fit both, voltage and current. The file naming, however, is unique. A filter prevents you from loading a WAVE_I file after you have selected “Arbitrary --> U” in the function generator menu. The file would not be listed as selectable at all.

► How to load a sequence table (100 sequences) from a USB flash drive:



1. Do not plug the USB drive yet or remove it.
2. Access the function selection menu of the function generator with MENU -> Function Generator -> Arbitrary -> U/I, to see the main screen of sequence selector, as depicted to the right.
3. Tap touch area

, then

and follow the instructions on screen. If at least one valid files has been recognized (for file and path naming see above), the device will show a list of files to select from with .
4. Tap touch area

in the bottom right corner. The selected file is then checked and loaded, if valid. In case it is not valid, the device will show an error message. Then the file must be corrected and the steps repeated.

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► How to save a sequence table (100 sequences) to a USB flash drive:

1. Do not plug the USB flash drive yet or remove it.
2. Access the function selection menu of the function generator via MENU -> Function Generator -> Arbitrary
3. Tap on

, then

. The device will request you to plug the USB flash drive now.
4. After plugging it, the device will try to access the flash drive and find the folder HMI_FILES and read the content. If there are already WAVE_U or WAVE_I files present, they will be listed and you can either select one for overwriting with , otherwise select

for a new file.
5. Finally save the sequence table with

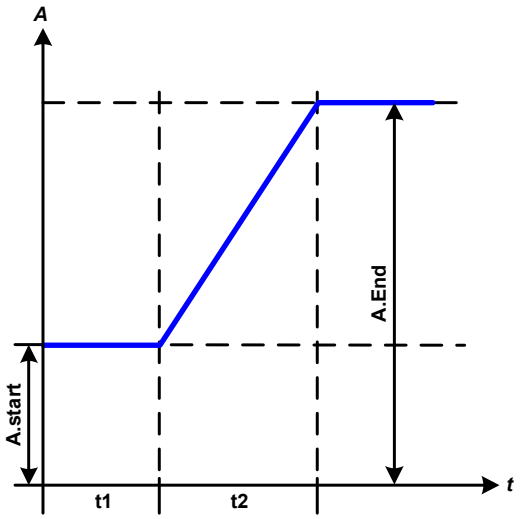
.

3.9.11 Ramp function

The following parameters can be configured for a ramp function.

Value	Range	Description
Ustart / Istart	0...Nominal value of U, I	Start value (U,I)
Uend / Iend	0...Nominal value of U, I	End value (U, I)
t1	0,1 ms...36000 s	Time before ramp-up or ramp-down of the signal.
t2	0.1 ms...36000 s	Ramp-up or ramp-down time

Schematic diagram:



Application and result:

This function generates a rising or falling ramp between start and end values over the time t2. Time t1 creates a delay before the ramp starts.

The function runs once and stops at the end value. To have a repeating ramp, function Trapezoid would have to be used instead (see *3.9.8*).

Important to consider are the static values of U and I which define the start levels at the beginning of the ramp. It is recommended that these values are set equal to those in A.start, unless the load at the DC output should not be provided with voltage before the start of the ramp. In that case the static values should be set to zero.

10h after reaching the ramp end, the function will stop automatically (i.e. I = 0 A, in case the ramp was assigned to the current), unless it has been stopped manually before.

3.9.12 UI and IU table functions (XY table)

The UI and IU functions offer the user the possibility to set a DC output current dependant on the DC output voltage, or a DC output voltage dependant on the DC output current. The function is table driven with exactly 4096 values, which are distributed over the whole measured range of actual output voltage or output current in the range of 0...125% Unom or Inom. The table can either be uploaded from a USB flash drive through the front side USB port of the device or via remote control (ModBus protocol or SCPI). The functions are:

UI function: U = f(I)

IU function: I = f(U)

In the **UI function**, the equipment measuring circuit determines the level from 0 to maximum of the output current. For each of the 4096 possible values for output current a voltage value is maintained by the user in the UI table which can be any value between 0 and nominal value. The values uploaded from a USB flash drive will always be interpreted as voltage values even if the user calculated them as current values and incorrectly loaded them as a UI table. The UI function suits very good for the simulation of fuel cell characteristics.

In the **IU function** the assignment of the values is the other way round, the behaviour, however, the same.

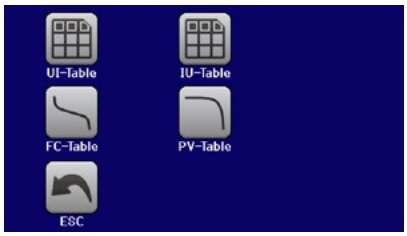
Thus the behaviour of the load or the current and power consumption can be controlled with dependance on output voltage and step changes can be created.

The IU function suit very good for the simulation of solar panels in photovoltaics related tests.

	Uploading of a table from a USB flash drive must use text files in CSV format (.csv). Plausibility is checked on loading (values not too high, number of values correct) and possible errors reported in which case the table will not be loaded.*

	The 4096 values in the table are only checked for size and count. If all the values were to be graphically plotted, a curve would be created which could include significant step changes in current or voltage. That could lead to complications for connected loads if, for example, the internal current measurement in the power supply swings slightly so that the voltage jumps backwards and forwards between two values in the table, which, in the worst case, could be 0 V and the maximum voltage.

3.9.12.1 Loading UI and IU tables from USB drive



The so-called UI or IU value tables can be loaded from a file via a standard USB flash drive that is formatted as FAT32. In order to load the file, it has to meet following specifications:

- The file name always begins with IU or UI (not case-sensitive), depending on which of the two function you load the table for
- The file must be a text file of type Excel CSV (semicolon as separator) and must only contain one column with exactly 4096 values without gaps
- Values with decimal places must use the commas (“,”) as decimal separator
- No value may exceed the nominal value of the device. For example, if you have an 80 V model and you are going to load a table with values for voltage, none of the 4096 values may be higher than 80 V (the adjustment limits from the device’s front panel do not apply here)
- The file(s) has/have to be put inside a folder named HMI_FILES in the root of the flash drive

If these specifications are not met, the device won’t accept the file and put out an error message in the display. Files with names beginning different to UI or IU are not recognized for this purpose. The USB drive may contain multiple UI/IU files with different names and list them for the selection of one.

► How to load a UI or IU table from a USB drive:

1. Do not plug the USB drive yet or pull it out if already plugged.
2. Open the function selection menu of the function manager with MENU -> Function Generator -> XY Table
3. In the next scree select the desired function with either “UI Table” or “IU Table”.
4. Configure the global parameters for U, I and P, if necessary.
5. Tap touch area

and plug the USB drive when requested, in order to select one out of X compatible files from the drive. In case the file is not accepted, the device will report an error in the display and also tell what’s wrong with the file.
6. Once the file is accepted, you will be requested to remove the USB drive.
7. Submit and load the function with

to start and control it as with other function (also see *„3.9.4.1. Function selection and control“).*

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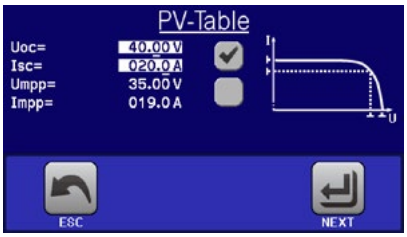
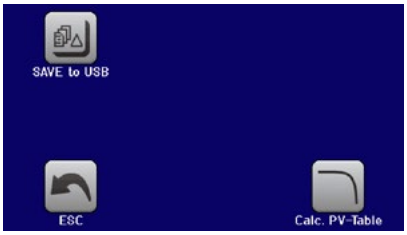
3.9.13 PV table function (photovoltaics)

3.9.13.1 Preface





This function uses the standard XY generator to let the power supply simulate solar panels or solar cells with certain characteristics. The device calculates an IU table from four typical values.

While the function is running, the user can adjust a parameter “Irradiance” between 0% (darkness) and 100% (bright light) in 1% steps to simulate different light situations.

The most important characteristics of a solar cell are:

- the short-circuit current (I_{SC}), which is proportional to the irradiance
- the open circuit voltage (U_{OC}), which almost reaches its maximum value even in low light situations
- the maximum power point (MPP), at which the solar panel can provide the maximum output power

The voltage of the MPP (here: U_{MPP}) lies typically 20% below U_{OC}, the current of the MPP (here: I_{MPP}) lies typically 5% below I_{SC}. In case there are no definite values for the simulated solar cell available, Impp and Umpp can be set to this rule of thumb. The device limits the I_{MPP} value to I_{SC} as upper limit, the same applies for U_{MPP} and U_{OC}.

3.9.13.2 Safety notices

Due to high capacities on the DC outputs of the power supplies of this series, not every available solar inverter can be operated without problems. Check the technical specifications of the solar inverter and probably contact the manufacturer for an evaluation. In case option HS is installed in the device (see *„1.9.5. Options“*), the result of operating critical inverters can be optimised.

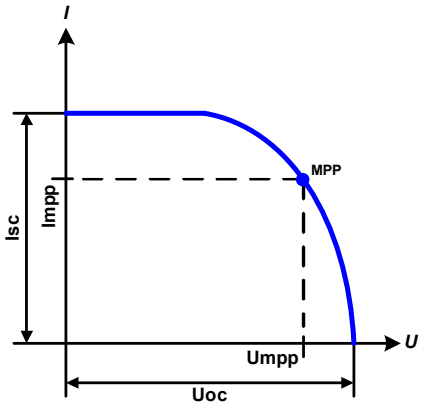
3.9.13.3 Usage

In the PV table function, which is based upon the XY generator with IU characteristics, the MPP is defined by the two adjustable parameters Umpp and Impp (also see diagram below). These parameters are usually stated in data sheets of solar panels and have to be entered here.

The following parameters can be set for the PV table function:

Value	Range	Description
Uoc	Umpp...Nominal device voltage	Open circuit voltage at no load
Isc	Impp...Nominal device current	Short-circuit current at max. load and low voltage
Umpp	0 V...Uoc	DC output voltage at the MPP
Impp	0 A...Isc	DC output current at the MPP

Schematic diagram:

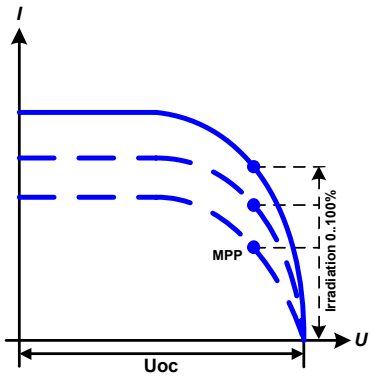


Application and result:

Adjust all four parameters on screen to the desired values. Whether the calculated IU and P curves, which result from those values, make sense or not can be verified with a tool (Excel table or small software), which is either included with the device on CD or can be obtained upon request. The tool visualises the curves as calculated from the adjusted values.

While the simulation is running, the user can see from the actual values (voltage, current, power) of the DC output, where the operating point of the power supply resp. of the simulated solar panel is. The adjustable value **Irradiance** (0%...100% in 1% steps, see screenshot below) helps to simulate different light situations from darkness (no power output) to the minimal amount of light that is required to make the panel provide full power.

Varying this parameter shifts the MPP and the PV curve along the Y axis. Also see diagram to the right. The value Irradiance is here used as a factor for the current Impp. The curve itself is not permanently re-calculated.



► How to configure the PV table

1. In the function generator menu tap on

, then

and then

.
2. Adjust the four parameters as required for the simulation.
3. Do not forget to adjust the global limits for voltage and power in the next screen which you can access with touch area

. The voltage (U) setting should be at least as high as U_{oc}, or higher.
4. After setting the values for the required signal generation, tap on touch area

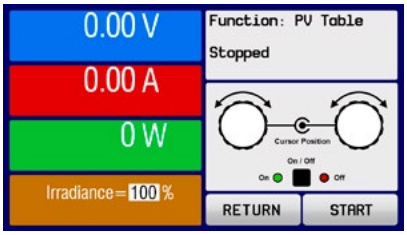
.

While loading, the IU function is calculated and sent to the internal XY generator. After this, the function is ready to run.

> *The function can be saved to USB flash drive as table, as well as read via any of the digital interfaces. In remote control, the function can't be loaded or controlled.*

From the screen where the XY function generator is controlled manually (start/stop), you can go back to the first screen of PV table function and use the formerly locked touch area to save the table to USB drive. In order to do so, follow the on-screen instructions. The table can be used to analyse the values or to visualise it in Excel or similar tools.

► How to work with the PV table function

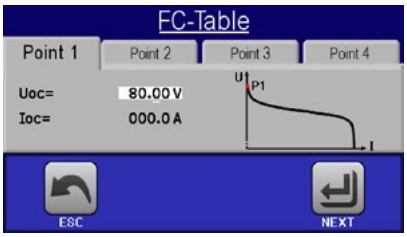


1. With an appropriate load connected, for example a solar inverter, start the function as described in *3.9.4.1*.
2. Adjust value **Irradiance** with any rotary knob between 100% (default) and 0%, in order to reproduce different light situations for the simulated panel. The actual values on the display indicate the working point and can show whether the simulation has arrived at the MPP or not.
3. Stop the function run anytime as described in *3.9.4.1*.

3.9.14 FC table function (fuel cell)

3.9.14.1 Preface

The FC table function is used to simulate the characteristics of voltage and current of a fuel cell. This is achieved by setting up some parameters which define points on a typical fuel cell curve, which is then calculated as UI table and passed to the internal function generator.

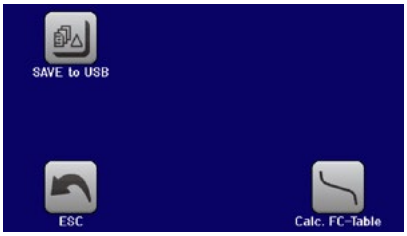


The user has to adjust value for four support points. The device will request to enter them step by step, indicating the actual point on screen with small graphics. When finished, these points will be used to calculate the curve.

Generally, following rules apply when setting up those values:

- $U_{Point1} > U_{Point2} > U_{Point3} > U_{Point4}$
- $I_{Point4} > I_{Point3} > I_{Point2} > I_{Point1}$
- Values of zero are not accepted

It means, the voltage has to decrease from point 1 to point 4, while the current has to increase. In case the rules are not followed, the device will reject the values with an error and reset them to 0.



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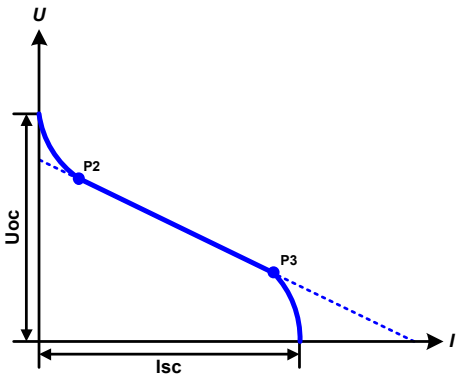
3.9.14.2 Usage

The following parameters can be set for the FC table function:

Value	Range	Description
Point 1: Uoc	0 V...U_{Nom}	Open circuit voltage at no load
Point 2+3: U	0 V...U_{Nom}	Voltage and current define the position of these two points in the U-I coordinate system, which represent two supporting points on the curve to be calculated
Point 2+3: I	0 A...I_{Nom}	
Point 4: Isc	0 A...I_{Nom}	DC output current at the MPP

All these parameters all freely adjustable and thus an unrealistic curve could result. In some situations, the device would show a "Calculation error" after you tapped LOAD and loading of the function will be aborted. In this situation, check your settings, probably revise and try again.

Schematic diagram:



Application and result:

After setting up the four supporting points P1 thru P4, whereas P1 is at position Uoc and 0 A and P4 is at position Isc and 0 V, the device will calculate the function as UI table and load it to the XY generator.

Depending on the load current, which can be between 0 A and Isc, the device will set a variable output voltage, whose progress between 0 V and Uoc should result in a curve similar to the one depicted to the left.

The slope between P2 and P3 is depending on the values adjusted for P2 and P3 and can be freely modified as long as P3's voltage is lower than the one of P2 and P3's current is higher than the one of P2.

► How to configure the FC table

1. In the function generator menu tap on

, then

and then

.
2. Adjust the parameters of the four supporting points, as required for the simulation.
3. Do not forget to adjust the global limits for current and power in the screen which you can access with touch area

.
4. After setting the values for the required signal generation, tap on touch area

.

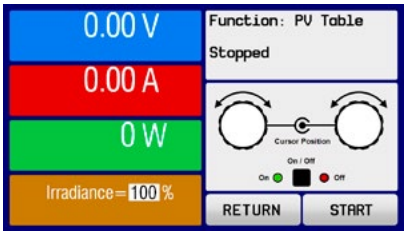
After the function has been loaded to the internal XY generator, the simulation is ready to start.

The function can be saved to USB flash drive as table, as well as read via any of the digital interfaces. In remote control, the function can't be loaded or controlled.

From the screen where the XY function generator is controlled manually (start/stop), you can go back to the first screen of the FC table function and use the formerly locked touch area to save the table to USB drive. In order to do so, follow the on-screen instructions. The table can be used to analyse the values or to visualise it in Excel or similar tools.

► How to work with the FC table function

1. With an appropriate load connected, for example a DC-DC converter, start the function as described in *3.9.4.1*.
2. The output voltage will be set depending on the load current, which is defined by the connected load, and will decrease with increasing current. Without any load, the voltage will rise to the adjusted Uoc value.
3. Stop the function run anytime as described in *3.9.4.1*.



3.9.15 Remote control of the function generator

The function generator can be remotely controlled but configuration and control of the functions with individual commands is different from manual operation. The external documentation “Programming Guide ModBus & SCPI” explains the approach. In general the following apply:

- The function generator is not controllable via the analog interface
- The function generator is unavailable if R mode (resistance) is activated
- Some functions are based on the arbitrary generator, some on the XY generator. Therefore, both generators have to be controlled and configured separately

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3.10 Other applications

3.10.1 Parallel operation in master-slave (MS)

Multiple devices of same kind and model can be connected in parallel in order to create a system with higher total current and hence higher power. For master-slave operation, the units are usually connected with their DC outputs, their Share bus and their digital master-slave bus.

The master-slave bus is a digital bus which makes the system work as one big unit regarding adjusted values, actual values and status.

The Share bus is intended to balance the units dynamically in their output voltage, i.e. in CV mode, especially if the master unit runs a function like sine wave etc. In order for this bus to work correctly, at least the DC minus poles of all units have to be connected, because DC minus is the reference for the Share bus.

3.10.1.1 Restrictions

Compared to normal operation of a single device, master-slave operation has some *restrictions*:

- The MS system reacts differently in alarm situations (see below in *3.10.1.6*)
- Resistance setting and control (CR) is not available. In case, master-slave is not activated in the menu of the devices, switching to and use of R mode is not blocked, but R mode will not work correctly in a parallel connection
- Using the Share bus makes the system reacts as dynamically as possible, but it is still not as dynamic as single unit operation
- Depending on the installed firmware version for the KE and HMI unit, it can occur that not every value related to the current or power of the MS system is translated to match the nominal values during the master-slave operation. This applies for manual control, but primarily for remote control when using the command language SCPI. It means, while you can set the current of a MS system, consisting of 2x PSI 9080-340 and with 680 A nominal current, to 680 A with the corresponding command, you not be able to do so with other current related values like “I max, “OCP” or “OCD”. Which values are actually affected in your device can only be found out by trying. In this situation these value can only translating them for a single unit. For example, if you want to set 500 A for OCP and the device would reject the value with an error “Upper limit exceeded”, it would have to be divided by the number of units before sending it again. The correct number of unit of the initialised MS system can be read from the master. Since this number can vary, it is not recommended to use a constant. After the value has been sent successfully, it is transferred 1:1 to the slaves so the resulting current of the MS system will match the desired current.

3.10.1.2 Wiring the DC outputs

The DC output of every unit in the parallel operation is connected with correct polarity to the next unit, using cables with cross section according to the maximum current and with short as possible length.

3.10.1.3 Wiring the Share bus

The Share bus is wired from unit to unit with an ideally twisted pair of cables with non-critical cross section. We recommend to use 0.5 mm² to 1.0 mm².

- The Share bus is poled. Take care for correct polarity of the wiring!
- In order for the Share bus to work correctly it requires at least to connect all DC minus outputs of the devices

A max. of 10 units can be connected via Share bus.

3.10.1.4 Wiring and set-up of the digital master-slave bus

The master-slave connectors are built-in and can be connected via network cables (≥CAT3, patch cable). After this, MS can be configured manually (recommended) or by remote control. The following applies:

- Type of connection: RS485 with 115200Bd
- A maximum 10 units can be connected via the bus: 1 master and up to 9 slaves.
- Only devices of same kind, i.e. power supply to power supply, and of the same model, such as PSI 9080-170 3U to PSI 9080-170 3U.
- Units at the end of the bus must be terminated (see below)

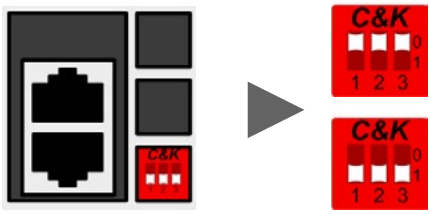
The master-slave bus (RS485) must not be wired using crossover cables!

Later operation of the MS system implies:

- The master unit displays, or makes available to be read by the remote controller, the sum of the actual values of all the units
- The ranges for setting the values, adjustment limits, protections (OVP etc.) and user events (UVD etc.) of the master are adapted to the total number of units. Thus, if e.g. 5 units each with a power of 5 kW are connected together to a 25 kW system, then the master can be set in the range 0...25 kW.

► How to connect the digital master-slave bus

1. Switch off all units that are to be connected and connect them with network cables (CAT3 or better, cables not included). It doesn't matter which of the two master-slave connection sockets (RJ45, backside) is connected to the next unit.
2. Depending on the desired configuration the units can then be connected at the DC side.
3. The two units at the beginning and end of the chain should be terminated, if long connection cables are used. This is achieved using a 3-pole DIP switch which is positioned on the back side of the unit next to the MS connectors.



Position: not terminated (standard)

Position: terminated

Now the master-slave system has to be configured on each other unit. It is recommended to configure first all the slave units and then the master unit.

► Step 1: Configuring all slave units

1. Enter MENU then GENERAL SETTINGS and press ▼ until reaching PAGE 8.
2. Activate the MS mode with touch area SLAVE. A warning requester will appear which has to be acknowledged with OK, otherwise the change will be reverted.
3. Set the address of the slave between 1 and 15 with the left-hand rotary knob. Ensure that no address is allocated twice.
4. Accept the settings with the touch area ENTER and return to the main page.

The slave is then configured for master-slave. Repeat the procedure for all other slave units.

► Step 2: Configuring the master unit

1. Enter MENU then GENERAL SETTINGS and press ▼ until reaching PAGE 8.
2. Specify the unit as master with tough area MASTER. A warning requester will appear which has to be acknowledged with OK, otherwise the change will be reverted.
3. Accept the settings with the touch area ENTER and return to the main page.

► Step 3: Initializing the master

The master unit and the whole master-slave system must now be initialized, which is done automatically after the master unit has been activated for MS. In the main page, after quitting the setting menus, a pop-up will appear:

Tapping INITIALIZE will cause the unit to search again for slaves and then to configure itself for set and actual values accordingly. If more than one correctly configured unit is found then this screen will show the number of slaves and the combined total current and total power.

If no slaves are found, or the correct number is not displayed, then the settings of all the slaves and the master together with the cabling must be checked and setup process repeated.

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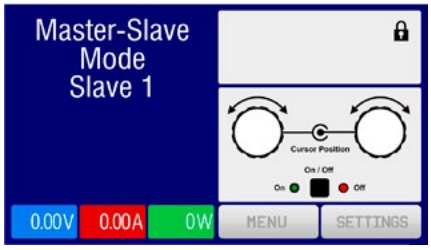
The initialising process of the master and the master-slave system will, as long as MS mode is still activated, be repeated each time the units are powered. The initialisation can be repeated anytime via the MENU in GENERAL SETTINGS, PAGE: 9.

3.10.1.5 Operating the master-slave system

After successful configuration and initialisation of the master and slave units, they will show their status in the displays. While the master merely shows “Master” in the status area, the slave(s) will continuously show like this, as long they are in remote control by the master:



It means, as long as a slave unit is in control by the master, it won’t display any set values, but actual values, and it will show the DC output status and possible alarms.

The slaves can no longer be controlled manually or remotely, neither via the analog nor via digital interfaces. They can, if needed, be monitored by reading actual values and status.

The display on the master unit changes after initialisation and all set values are reset. The master now displays the set and actual values of the total system. Depending on the number of units, the total current and power will multiply. The following applies:

- The master can be treated like a standalone unit
- The master shares the set values across the slaves and controls them
- The master is remotely controllable via the analog or digital interfaces
- All settings for the set values U,I and P (supervision, limits etc.) should be adapted to the new total values
- All initialised slaves will reset any limits (U_{Min}, I_{Max} etc.), supervision thresholds (OVP, OPP etc.) and event settings (UCD, OVD etc.) to default values, so these don’t interfere the control by the master

In order to easily restore all these settings values to what was before activating MS operation, it is recommended to make use of the user profiles (see “3.8. Loading and saving a user profile”)

- If one or more slaves report an device alarm, it will be displayed on the master and must be acknowledged there so that the slave(s) can continue their operation. Since an alarm causes the DC output to be switched off and it can only reinstate automatically after PF or OT alarms, it can be required to switch it on again by the operator or by a remote control software.
- Loss of connection to any slave will result in shutdown of all DC outputs, as a safety measure, and the master will report this situation in the display with a pop-up “Master-slave security mode”. Then the MS system has to be re-initialised, either with or without re-establishing connection to the disconnected unit(s) before.
- All units, even the slaves, can be externally shut down on the DC outputs using the pin REM-SB of the analog interface. This can be used as some kind of emergency off, where usually a contact (maker or breaker) is wired to this pin on all units in parallel.

3.10.1.6 Alarms and other problem situations

Master-slave operation, due to the connection of multiple units and their interaction, can cause additional problem situations which do not occur when operating individual units. For such occurrences the following regulations have been defined:

- If the DC part of one or more slave units is switched off due to defect, overheating etc., the whole MS system shuts down the power output and human interaction is required
- If one or more slave units are cut from AC supply (power switch, blackout, supply undervoltage) and come back later, they’re not automatically initialised and included again in the MS system. Then the init has to be repeated.
- If the DC output of the master unit is switched off due to a defect or overheating, then the total master-slave system cannot provide output power and the DC outputs of all slaves are automatically switched off, too
- If the master unit is cut from AC supply (power switch, blackout) and comes back later, the unit will automatically initialise the MS system again, finding and integrating all active slaves. In this case, MS can be restored automatically.
- If accidently multiple or no units are defined as master the master-slave system cannot be initialised

In situations where one or multiple units generate a device alarm like OV etc. following applies:

- Any alarm of a slave is indicated on the slave's display and on the master's display
- If multiple alarms happen simultaneously, the master only indicates the most recent one. In this case, the particular alarms can be read from the slave units displays or via digital interface during remote control or remote supervision.
- All units in the MS system supervise their own values regarding overvoltage, overcurrent and overpower and in case of alarm they report the alarm to the master. In situations where the current is probably not balanced between the units, it can occur that one unit generates an OCP alarm though the global OCP limit of the MS system was not reached. The same can occur with the OPP alarm.

3.10.2 Series connection

Series connection of two or multiple devices is basically possible. But for reasons of safety and isolation, following restrictions apply:

- Both, negative (DC-) and positive (DC+) output poles, are connected to PE via type X capacitors
- None DC minus pole of any unit in the series connection must have a potential against ground (PE) higher than specified in the technical data! The maximum allowed potential shift varies from model to model and is different for DC plus and DC minus
- The Share Bus must not be wired and used!
- Remote sensing must not be used!
- Series connection is only allowed with devices of the same kind and model, i.e. power supply with power supply, like for example PS/PSI 9080-170 3U with PSI 9080-170 3U or PS 9080-170 3U

Series connection in Master-Slave mode is not supported. It means, all units have to controlled separately regarding set values and DC output status, whether it is manual control or remote control (digital or analog).

Due to the max. allowed potential shift on the DC output certain models are not allowed for series connection at all, like the 1000 V model, because the DC plus there is only isolated up to 1000 V. On the contrary, two 500 V models are eligible for series connection.

Analog interfaces on the units in serial connection can be connected in parallel, because they are galvanically isolated. It is also allowed to ground the GND pins of the analog interfaces connected in parallel, which may happen automatically, when connecting them to a controlling device such as a PC, where grounds are directly tied to PE.

3.10.3 Operation as battery charger

A power supply can be used as a battery charger, but with some restrictions, because it misses a battery supervision and a physical separation from the load in form of a relay or contactor, which is featured with some real battery chargers as a protection.

Following has to be considered:

- No false polarity protection inside! Connecting a battery with false polarity will damage the power supply severely, even if it is not powered.
- All models of this series have an internal circuit, i.e. base load, for faster discharge of voltage when switching the DC output off or ramping voltage down. This base load would, more or less slowly, discharge the battery while the DC output is switched off, means while it is not charging. This would, however, not occur when the power supply is not powered at all. It is thus recommended to leave the DC output switched on as long as the battery is connected (equals to trickle charge) and only switch if off for connecting/disconnecting a battery.

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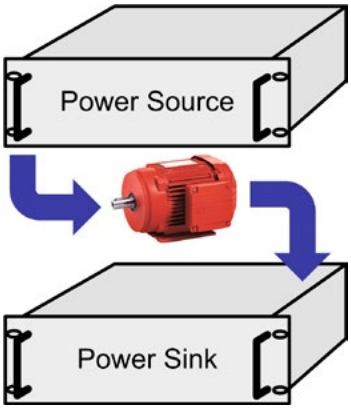
3.10.4 Two quadrants operation (2QO)

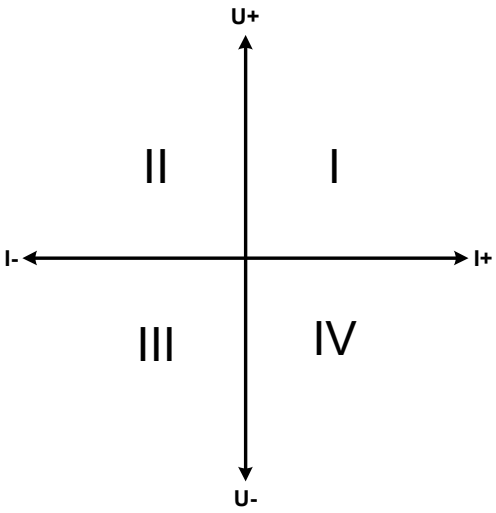
3.10.4.1 Introduction

This way of operating refers to the use of a source, in this case a power supply of series PSI 9000 3U, and a sink, in this case a series ELR 9000 electronic load. The source and the sink function alternatingly in order to test a device, such as a battery, by deliberately charging and discharging it as part of a functional or final test.



The user can decide whether the system is operated manually or the power supply only as the dominant unit or both devices should be controlled by PC. We recommend to focus on the power supply, which is intended to control the load via the Share Bus connection. The two quadrants operation is only suitable for constant voltage operation (CV).

Clarification:



A combination of source and sink can only map the quadrants I + II. This means that only positive voltages are possible. The positive current is generated by the source or application and the negative current flows into the load..

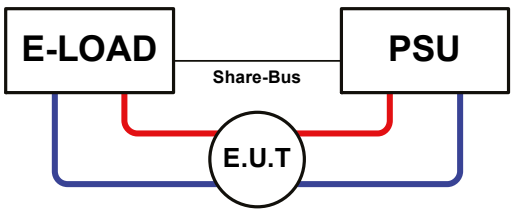
The maximum approved limits for the application should be set in the power supply. This can be done via the interface. The electronic load should preferably be in operating mode CV. The load will then, using the Share Bus, control the output voltage of the power supply.

Typical applications:

- Fuel cells
- Capacitor tests
- Motor driven applications
- Electronic tests where a high dynamic discharge is required.

3.10.4.2 Connecting devices to a 2QO

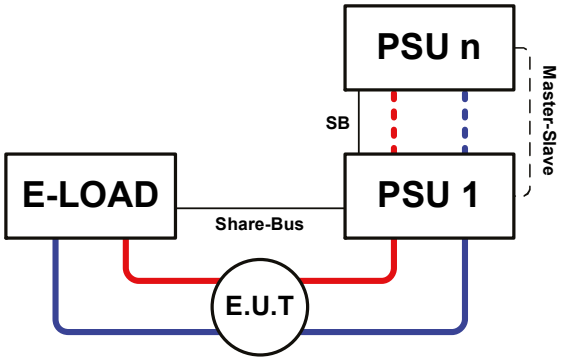
There are a number of possibilities to connect source(s) and sink(s) to make a 2QO:



Configuration A:

1 e-load and 1 power supply, plus 1 test object (E.U.T).

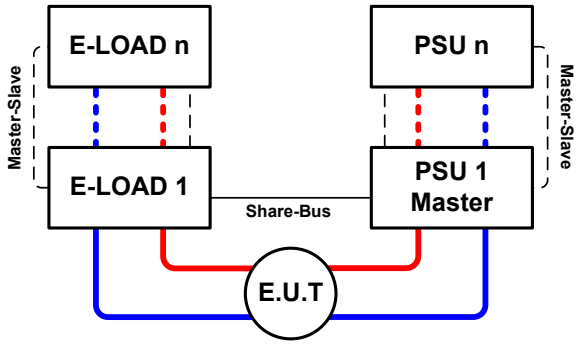
This is he most common configuration for 2QO. The nominal values for U,I and P of the two devices should match, such as ELR 9080-170 and PSI 9080-170 3U. The system is controlled by the power supply, which has to be set to be “Master” in the setup menu, even though there is no master-slave operation running.



Configuration B:

1 e-load and multiple power supplies, plus 1 test object (E.U.T).

For adapting the total power of the power supply device to the possibly higher input power of the load, the power supplies are connected via Master-Slave and the load’s current is shared across the power supplies when wiring the Share bus to gain a balanced load distribution. The digital master-slave bus can be wired if installed on the power supply units. One PSU, preferable PSU 1, has to be set to Master for the Share bus connection, no matter if MS operation via the digital MS bus used or not.



Configuration C:

Multiple e-loads and Multiple power supplies, plus 1 test object (E.U.T), for raising the total performance.

The combination of load units and power supply units each create a block, a system with certain power. Here it is also necessary to match the nominal values of the two systems, i.e an 80 V DC input of the loads to a max. 80 V DC output of the power supplies. The max. number of 10 units cannot be exceeded. Regarding the Share bus connection, all e-load units have to be slaves, while one of the PSUs has to be set as master.

In case the digital master-slave bus, where featured, is also wired, one load unit will be defined as master for the MS system of load, but still has to be slave on the Share bus, which is activated with parameter “PSI/ELR system” in the setup menu.

3.10.4.3 Settings on the devices

Regarding the general 2QO operation where the Share bus connection is sufficient, no extra setup is required on the load unit(s). On any of the power supplies, but preferably PSU 1, you need to activate master-slave mode and set it to MASTER, unless it is already the master unit of a master-slave system over digital MS bus. Refer to the documentation of the power supply for further information. Also see *3.4.3.1*.

For safety of the connected E.U.T / D.U.T and to prevent damage, we recommend to adjust supervision thresholds like OVP, OCP or OPP on all units to the desired levels, which will then switch off the DC output resp. the DC input in case of excess.

3.10.4.4 Restrictions

After all electronic loads have been connected to the Sharebus with one power supply as master, they cannot limit their input voltage anymore to what you adjust as “U set” on the device. The correct voltage level comes from the master unit and has to be adjusted there.

3.10.4.5 Application example

Charging and discharging a battery with 24 V/400 Ah, using configuration A from above.

- Power supply PSI 9080-170 3U with: I_{Set} = 50 A, P_{Set} = 5000 W
- Electronic load ELR 9080-170 set to: I_{Set} = max. discharging current of the battery (eg. 100 A), P_{Set} = 3500 W, plus probably UVD = 20 V with event type “Alarm” to stop discharging at a certain low voltage threshold
- Assumption: battery has a voltage of 26 V at test start
- DC input(s) and DC output(s) of all units switched off

In this combination of devices it is recommended to always switch on the DC output of the source first and then the DC input of the sink.

1. Discharge of the battery to 24 V

Setup: Voltage on the power supply set to 24 V, DC output of power supply and DC input of load activated

Reaction: the e-load will load the battery with a maximum current of 100 A in order to discharge it to 24 V. The power supply delivers no current at this moment, because the battery voltage is still higher than what is adjusted on the power supply. The load will gradually reduce the input current in order to maintain the battery voltage at 24 V. Once the battery voltage has reached 24 V with a discharge current of approx. 0 A, the voltage will be maintained at this level by charging from the power supply.

The power supply determines the voltage setting of the load via the Share bus. In order to avoid deep discharge of the battery due to accidentally setting the voltage on the power to a very low value, it is recommended to configure the undervoltage detection feature (UVD) of the load, so it will switch off the DC input when reaching minimum allowed discharge voltage. The settings of the load, as given via the Share bus, can’t be read from the load’s display.

2. Charging the battery to 27 V

Setup: Voltage on the power supply set to 27 V

Reaction: the power supply will charge the battery with a maximum current of 50 A, which will gradually reduce with increasing voltage as a reaction to the changing internal resistance of the battery. The load absorbs no current at this charging phase, because it is controlled via the Share bus and set to a certain voltage, which is still higher than the actual battery voltage and the actual output voltage of the power supply. When reaching 27 V, the power supply will deliver only the current needed to maintain battery voltage.

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4. Service and maintenance

4.1 Maintenance / cleaning

The device needs no maintenance. Cleaning may be needed for the internal fans, the frequency of cleanse is depending on the ambient conditions. The fans serve to cool the components which are heated by the inherent power loss. Heavily dirt filled fans can lead to insufficient airflow and therefore the DC output would switch off too early due to overheating or possibly lead to defects.

Cleaning the internal fans can be performed with a vacuum cleaner or similar. For this the device needs to be opened.

4.2 Fault finding / diagnosis / repair

If the equipment suddenly performs in an unexpected way, which indicates a fault, or it has an obvious defect, this can't and must not be repaired by the user. Contact the supplier in case of suspicion and elicit the steps to be taken.

It will then usually be necessary to return the device to the supplier (with or without guarantee). If a return for checking or repair is to be carried out, ensure that:

- the supplier has been contacted and it is clarified how and where the equipment should be sent.
- the device is in fully assembled state and in suitable transport packaging, ideally the original packaging.
- optional extras such as an AnyBus interface module is included if this is in any way connected to the problem.
- a fault description in as much detail as possible is attached.
- if shipping destination is abroad, the necessary customs papers are attached.

4.2.1 Replacing a defect mains fuse

The device is protected by up to six 6.3 x 32 mm fuses (T16 A, 500 V, ceramic) inside the device. To replace these the device must first be disconnected from AC supply and then opened. Inside are 1~3 power modules in black plastic housings, each of which holds two of the fuses.

Opening the device and replacing the fuses must only be carried out by technically trained personnel!

Tools required: Torx 10 screwdriver, flat screwdriver (approx. 5 mm), multimeter

► Step 1: Opening the device

1. Switch off at the mains switch and remove plug.
2. Remove the top cover of the device (5 screws at the back, 5 on the front, 7 on each side, all Torx 10)
3. Remove the plastic cover(s) of the power modules.

► Step 2: Replacing a defect fuse.

1. As it is usually unknown which fuse is defect, they should all be checked. The fuses are on the front side wall (looking from the front of the device) of the power modules and are covered with a soft plastic cap.
2. Remove the soft plastic cap from the fuse to be tested and carefully prise out the fuse with a flat screwdriver.
3. Check whether the fuse is intact with a multimeter, and if defective, replace with a similar type (size, values, lag)
4. Repeat step 2 for all fuses.

Once all fuses have been checked and replaced, and if no other defect is apparent, the device can be reassembled (step 1 in reverse order).

4.3 Firmware updates

4.3.1 HMI firmware update

> Firmware updates should only be installed when they can eliminate existing bugs in the firmware in the device or contain new features.

The control panel (HMI) can be updated via the front or back USB ports, whereby the back USB port requires a PC with suitable software and the front USB only requires a FAT32 formatted USB flash drive with the update file. Hence the latter option is much simpler.

► How to update the control panel (HMI) firmware

1. If not already available, obtain a USB flash drive (capacity up to 32GB) and ensure that it is formatted as FAT32.
2. Create a folder with the name HMI_FILES (case sensitive!) in the root directory of the flash drive and copy the firmware update file to this folder. The file name must follow the begin with “update_hmi” (example: update_hmi_v100.bin) or with a number (example: 96230058_FW-BE1_V201.bin).
3. Tap the touch area MENU, then HMI SETTINGS, then HMI UPDATE and confirm the security question with ENTER. The HMI will then read and list the contents of the HMI_FILES folder.
4. Select and tick the update file to be used and tap the touch area LOAD FROM USB. The control panel will then be updated.
5. Switch the equipment off, wait until it is completely off (fan not running anymore), then switch back on.

4.3.2 Interface unit firmware update (KE)

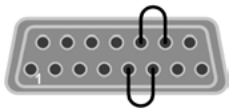
> Firmware updates should only be installed when they can eliminate existing bugs in the firmware in the device or contain new features.

The firmware of the device, if necessary, can be updated via the rear side USB port. For this the software “EA Power Control” is needed which is either included in the delivery of the device on CD or USB stick, as well as being available from as download from out website, together with the actual firmware update file. The software guides the user through the update process and contains an instruction manual.

In case the software is not available, or if the update somehow went wrong and the device will not work correctly, there is an alternative procedure. Required tools: 1x Sub-D plug 15-pole, some wire, solder iron, update file (*.bin).

► How to manually update the device firmware

1. Power off device. If not already available, prepare the 15 pole D-Sub plug like this (figure shows backside):



Bridge between pin 5 and 6

Bridge between pin 13 and 14

2. Plug the Sub-D onto the analog interface socket and connect the (included) USB-B cable between the USB port on the rear and the PC. Switch device on by mains switch.
3. The PC should mount a new removable drive named “EA UPDATE”, for example with driver lett G:. If not, wait some time and repeat steps 1 and 2.
4. Open that new drive in a suitable software, like Windows Explorer. It should contain one file “firmware.bin”. Delete the file.
5. Copy the new firmware file, which always has to be with extension *.bin, to that drive. Wait for the copy procedure to finish.
6. Switch the device off and remove the Sub-D plug from the analog interface socket.
7. Restart the device by switching it on - the display shows some information during the startup process, amongst them the new device firmware version as for example “KE: 2.10”.

The firmware update is finished then.

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4.4 Calibration

4.4.1 Preface

The devices of series PSI 9000 feature a function to re-adjust the most important output values when doing a calibration and in case these values have moved out of tolerance. The readjustment is limited to compensate small differences of up to 1% or 2% of the max. value. There are several reasons which could make it necessary to readjust a unit: component aging, component deterioration, extreme ambient conditions, high frequent use.

In order to determine if a value is out of tolerance, the parameter must be verified first with measurement tools of high accuracy and with at least half the error of the PSI device. Only then a comparison between values displayed on the PSI device and true DC output values is possible.

For example, if you want to verify and possibly readjust the output current of model PSI 9080-510 3U which has 510 A maximum current, stated with a max. error of 0.2%, you can only do that by using a high current shunt with max. 0.1% error or less. Also, when measuring such high currents, it is recommended to keep the process short, in order to avoid the shunt heating up too much. It is furthermore recommended to use a shunt with at least 25% reserve.

When measuring the current with a shunt, the measurement error of the multimeter on the shunt adds to the error of the shunt and the sum of both must not exceed the max. error of the device under calibration.

4.4.2 Preparation

For a successful calibration and readjustment, a few tools and certain ambient conditions are required:

- A measurement device (multimeter) for voltage, with a max. error of half the PSI's voltage error. That measurement device can also be used to measure the shunt voltage when readjusting the current
- If the current is also going to be calibrated: a suitable DC current shunt, ideally specified for at least 1.25 times the max. output current of the PSI and with a max. error that is half or less than the max. current error of the PSI device to calibrate
- Normal ambient temperature of approx. 20-25°C
- Warmed up PSI unit, which has been run for at least 10 minutes under 50% power
- One or two adjustable loads, preferably electronic ones, which are capable of consuming at least 102% of the max. voltage and current of the PSI device and which are calibrated and precise

Before you can start calibrating, a few measures have to be taken:

- Let the PSI device warm up for at least 10 minutes under 50% load, in connection with the voltage / current source
- In case the remote sensing input is going to be calibrated, prepare a cable for the remote sensing connector to DC output, but leave it yet unconnected
- Abort any form of remote control, deactivate master-slave mode, set device to **U/I** mode
- Install the shunt between PSI device and load and make sure the shunt is cooled somehow
- Connect external measurement device to the DC output or to the shunt, depending on whether the voltage is going to be calibrated first or the current

4.4.3 Calibration procedure

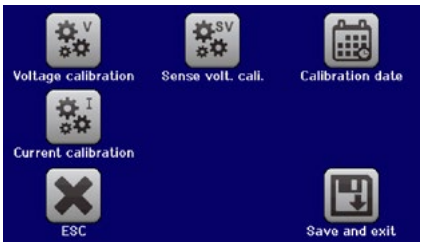
After the preparation, the device is ready to be calibrated. From now on, a certain sequence of parameter calibration is important. Generally, you don't need to calibrate all three parameters, but it is recommended to do so.

Important:

When calibrating the output voltage, the remote input "Sense" on the rear of the device has to be disconnected.

The calibration procedure, as explained below, is an example with model PSI 9080-170 3U. Other models are treated the same way, with values according to the particular PSI model and the required load.

4.4.3.1 Set values



► How to calibrate the output voltage

1. Connect a multimeter to the DC output. Connect a load and set its current to approx. 5% of the nominal current of the power supply, in this example ~8 A, and 0 V (if the load is electronic).
2. In the display, tap MENU, then „**General Settings**“, then go to **Page 6** and then tap **START**.
3. In the next screen select: **Voltage calibration**, then **Output voltage calibration** and **NEXT**. The power supply will switch the DC output on, set a certain output voltage and show the measured value as **U-mon**.
4. The next screen requests you to enter the measured output voltage from the multimeter at **Measured data=**. Enter it using the keypad, that appears when tapping the value. Assure yourself the value is correct and submit with **ENTER**.
5. Repeat step 4. for the next three steps (total of four steps).

► How to calibrate the output current

1. Set the load to approx. 102% nominal current of the PSI device, for the example model with 170 A this would be 173.4 A, rounded to 174 A.
2. In the display, tap MENU, then „**General Settings**“, then go to **Page 6** and then tap **START**.
3. In the next screen select: **Current calibration**, then **Output current calibration** and **NEXT**. The device will switch on the DC output, set a certain current limit while loaded by the load/sink and show the measured output current as **I-mon**.
4. The next screen requests you to enter the output current **Measured data=** measured with your shunt. Enter it using the keypad and assure yourself the value is correct and submit with **ENTER**.
5. Repeat step 4. for the next three steps (total of four steps).

In case you are generally using the remote sensing feature, it is recommended to also calibrate this feature for best results. The procedure is identical to the calibration of voltage, except for it requires to have the sensing connector (Sense) on the rear to be plugged and connected with correct polarity to the DC output of the PSI.

► How to calibrate the output voltage for remote sensing

1. Connect a load and set its current to approx. 5% of the nominal current of the power supply, in this example ~8 A, and 0 V (if the load is electronic). Connect a multimeter to the DC input of the load and connect the remote sensing input (Sense) to the DC input of the load with correct polarity.
2. In the display of the PSI tap MENU, then “**General Settings**”, then go to **Page 6** and then tap **START**.
3. In the next screen select: **Sense volt. calibration**, then **Output sense voltage calibration** and **NEXT.**
4. The next screen requests you to enter the measured sensing voltage **Measured data=** from your multimeter. Enter it using the keypad, that appears when tapping the value. Assure yourself the value is correct and submit with **ENTER**.
5. Repeat step 5. for the next three steps (total of four steps).

4.4.3.2 Actual values

Actual values of output voltage (with and without remote sensing) and output current are calibrated almost the same way as the set values, but here you don’t need to enter anything, just confirm the displayed values. Please proceed the above steps and instead of “**Output sense voltage**” select “**Display sense voltage**” in the submenus. After the device shows measured values on display, wait at least 2s for measured value to settle and then tap NEXT until you are through all steps.

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4.4.3.3 Save and exit

After calibration you may furthermore enter the current date as “calibration date” by tapping

in the selection screen and enter the date in format YYYY / MM / DD.

Last but not least save the calibration data permanently by tapping

.

Leaving the calibration selection menu without tapping “Save and exit” will discard calibration data and the procedure would have to be repeated!

5. Accessories and options

5.1 Overview

Accessories and options are, when necessary, delivered with their own documentation and are not detailed further in this document.

6. Service & Support

6.1 General

Repairs, if not otherwise arranged between supplier and customer, will be carried out by the manufacturer. For this the device must generally be returned to the manufacturer. No RMA number is needed. It is sufficient to package the equipment adequately and send it, together with a detailed description of the fault and, if still under guarantee, a copy of the invoice, to the following address.

6.2 Contact options

Questions or problems with operation of the device, use of optional components, with the documentation or software, can be addressed to technical support either by telephone or e-Mail.

Contact Us

United States

Intepro Systems, Inc.
14712-A Franklin Ave
Tustin, CA 92780
Tel: 1-714-953-2686
sales@inteproate.com
www.inteproate.com

United Kingdom

Intepro UK Ltd.
9 Lakeside Business Park
Swan Lane, Sandhurst Berkshire
GU47 9DN / UK
Tel: 44 012 5287 5600

China

Intepro Power
Block 7 Fourth Industrial Area
Nanyou, Nanshan District
Shenzhen, China 518052
Tel: 0086 755 86500020